Description

The invention relates to electronic packages and particularly to electronic packages which utilize a heat sink as part thereof. As defined below, the invention even further relates to electronic packages which utilize a thin film, flexible circuitized substrate as one element thereof.

Electronic packages which include semiconductor devices e.g., silicon chips) as part thereof are well known in the computer industry, with examples being shown and described in US-A-4 004 195, US-A-4 415 025 and US-A-4 593 342.

Use of high circuit densities in modern semiconductor devices, including particularly those which use the aforementioned thin film substrates, requires the effective removal of heat generated during package operation in order to assure that the operating parameters of such devices are maintained within specified tolerances so as to prevent destruction of the package from overheating. One well known means for providing such heat removal is to utilize a metallic heat sink or similar member which typically forms an integral part of the package. Representative examples of these means are described and illustrated in the aforementioned patents.

The electronic package of the instant invention provides for enhanced heat removal therefrom through the utilization of a heat spreader interposed between the package's semiconductor device and heat sink components. The device, electrically connected to a thin film, circuitized substrate, is in turn attached to a surface of the spreader which in turn is attached to a surface of the heat sink. Use of a thin film substrate enables the device to be finally oriented at a spaced location from the package's first substrate (e.g., printed circuit board). This arrangement, in addition to substantially promoting heat dissipation from the package also facilitates assembly thereof. Such a package, in which the device is at a spaced location from a first substrate, is described in FR-A-2 555 812.

It is therefore, a primary object of the invention as claimed to enhance the art of electronic packaging by providing a package possessing the several advantageous features cited herein.

In accordance with one aspect of the invention, there is provided an electronic package as set out in Claim 1.

For a better understanding of the present invention, together with other and further objects, advantages and capabilities thereof, in the following preferred embodiments of the invention are described with reference to the accompanying drawings, in which:

FIG. 1 is a front, elevational view, partly in section, of an electronic package;
FIG. 2 is a partial view, on an enlarged scale, of the package of FIG. 1;
FIG. 3 represents a partial view, partly in section, of an alternative embodiment of the invention; and
FIG. 4 is a partial view of leg segments which are used as part of the heat sink of the invention.

With particular attention to FIG. 1, there is shown an electronic package 10. Package 10 includes a rigid, first circuitized substrate 11 (e.g., a printed circuit board) comprised of an electrically insulative material (e.g., epoxy) and including a body portion 13 having predefined circuitry 15 (e.g., copper) thereon. A semiconductor device 17 (e.g., silicon chip) is positioned above substrate 11 and electrically coupled thereto, said coupling being provided by a thin film, flexible second circuitized substrate 19 which is electrically connected (e.g., at one end) to circuitry 15 and also connected (e.g., at the other end) to selected contact locations on the bottom (lower) surface of device 17. Understandably, the thin film substrate 19 is a significant part of the invention in that it not only provides the aforementioned coupling between device 17 and substrate 11 but also enables the device to be positioned at a spaced elevation above the upper surface 21 of substrate 11. This spacing is considered significant for manufacturing purposes (e.g., by facilitating flux cleaning during the aforementioned connection of substrate 19 to circuitry 15). Second substrate 19, as better shown in FIG. 2, comprises a thin layer of electrically insulative e.g., organic polymer) material 23 having thereon conductive, metallic (e.g., chrome-copper-chrome) circuitry 25. Circuitry 25 may be located on either an upper or lower surface of the insulative polymer 23. By the term thin is meant a substrate wherein the overall thickness thereof (including polymer and conductive circuitry) is within the range of only from about 25,4µm (0.001 inch) to about 254 µm (0.010 inch). This element is thus able to provide necessary flexibility at this portion of the invention such that the attached semiconductor device 17, during assembly, can be elevated to the position shown. A further description of the preferred method of assembling the invention is provided below.

As shown in FIG. 2, the circuity 25 of flexible substrate 19 includes projecting end portions 27 and 29 which, as shown, extend beyond the insulative polymer material. Reference numeral 27 represents the first of these projecting end portions which in turn are electrically connected (e.g., using thermal compression bonding) to the respective contact locations on the lower surface of device 17. In addition, the remaining second projecting end portions 29 are electrically connected (e.g., by soldering) to the aforementioned, respective conductive circuit lines 15 located on the upper surface 21 of substrate 11. The aforementioned connection techniques are known in the art and further definition is not believed necessary. Added protection for the semiconductor

device having the first projecting ends of substrate 19 attached thereto can be provided through the use of a protective top coating 31 (e.g., silicone or epoxy).

The preferred insulative material 23 for substrate 19 is a thermoset condensation polymer (e.g., polyimide) which is a dielectric, high temperature elastic material known in the art. Alternatively, a thermoplastic, non-condensation polymer could also be utilized. Defined circuitry (e.g., chrome-copper-chrome) is typically in blanket layer format and is secured to the thin film using blanket metallization techniques, followed by photolithographic and etching processes, several of which are known in the art. Further description is thus not believed necessary.

As shown in FIG. 1, package 10 further includes a heat sink 33, which as indicated, is preferably attached to the upper surface 21 of substrate 11 (e.g., using solder 34). The heat sink, in addition to providing heat dissipation for the invention, thus also serves to provide a cover for the package's internal components (e.g., device 17 and substrate 19). In order to provide enhanced heat path between the invention's heat sink and heat-generating semiconductor device component, the invention further includes a heat spreader 37 which, as shown, is secured along one surface thereof to device 17 and along a second, opposing surface thereof to heat sink 33. Thus, the heat spreader is joined to these components along first and second interfaces, respectively, as illustrated in greater detail in FIG. 2. To provide effective heat escape in accordance with the unique teachings of the invention, the heat spreader is selected from a material which possesses a coefficient of thermal expansion substantially similar to that of the attached device 17. By the term substantially similar as used in this regard is meant that the coefficients of thermal expansion of these two elements are identical to each other or wherein the difference in said coefficients is no greater than two parts per million (ppm) per degree Celsius (x 10^{-6} m/m per degree Kelvin). In a preferred embodiment of the invention, a silicon chip was used for device 17, and heat spreader 37 was selected from silicon carbide, aluminum nitride or copper-clad Invar (a trademark of the International Nickel Company) materials. Use of these materials enabled provision of semiconductor device and heat spreader elements each possessing a coefficient of thermal expansion of about 2.5 ppm/degree Celsius (x 10^{-6} m/m per degree Kelvin). As stated, the coefficients of thermal expansion of these two elements are preferably identical in order to assure the defined unique heat removal at this juncture of the invention.

To further assure sound heat transfer in accordance with the teachings of the invention, the adhesive material 41 along the defined first interface between device 17 and spreader 37 (and used to secure these two elements) was selected from a material possessing high thermal conductivity and a coefficient of thermal expansion also substantially similar to that of said elements. By the term substantially similar in this regard, however, is meant that the coefficient of thermal expansion of this adhesive does not exceed (differ from) that of either the device 17 or heat spreader by about 3.0 ppm/degree Celsius (x 10^{-6} m/m per degree Kelvin). More specifically, the coefficients of thermal expansion of all three of these elements (chip, heat spreader, first interface adhesive) fall within the range of about 2.0 to about 5.0 ppm/degree Celsius (x10^{-6} m/m per degree Kelvin). In a preferred embodiment, a diamond-filled epoxy was utilized for adhesive 41, this material possessing a coefficient of thermal expansion of about 3.0 ppm/degree Celsius (x 10^{-6} m/m per degree Kelvin). Additional adhesives possessing a slightly higher coefficient of thermal expansion (up to the aforementioned 5.0 ppm/degree Celsius) are also possible in order to accomplish the effective heat transfer defined herein. It is thus understood from the foregoing that the coefficient of thermal expansion of adhesive 41 may be somewhat larger than those of the two elements (device and spreader) which it serves to bond together. This is acceptable in the instant invention, provided the adhesive is very thin (e.g., within the range of about 25,4 µm (0.001 inches) to about 76,2 µm (0.003 inches)). Further, the defined material (diamond-filled epoxy) is also electrically insulative, in addition to being highly thermally conductive, as stated.

As particularly shown in FIG. 1, heat spreader 37 is significantly larger than the attached semiconductor device 17. In a preferred embodiment of the invention, heat spreader 37 possessed an overall external surface area at least twice that of the overall outer surface area of device 17. Utilization of such a large element results in an interface between the heat spreader and heat sink which, from a thermal standpoint, is not as sensitive as that interface between the spreader and semiconductor device elements. Therefore, an adhesive possessing a much lower thermal conductivity is acceptable. Accordingly, is not essential in order to provide the advantageous features cited herein that the coefficient of thermal expansion of heat sink 33 match that of spreader 37 or of the interim adhesive 51 used along the defined second interface to secure these components. In a preferred embodiment, when using the defined aluminum nitride or silicon carbide materials for spreader 17 or the defined metallic material (copper-clad Invar), it was possible to utilize known heat sink materials in the art, including aluminum or tin-plated copper. The corresponding adhesive material 51 used along this juncture (second interface) of the invention was, in a preferred embodiment of the invention, silicone filled with a thermal conductive material (e.g., zinc oxide). Alternatively, an epoxy of a type known in the art, also having the aforementioned zinc oxide thermally conductive material as a filler, could also be readily utilized. One such com-

position, excluding this filler, is available from 3M under the trade designation "Scotchcast". Such a composition contains about 47.6% by weight of an epoxy polymer, about 52% by weight of a hardener and flexibilizer mixture, and about 0.4% by weight of a coloring agent. The hardener and flexibilizer mixture contains about 25% to 39% of hexahydrophthalic anhydride, about 50% to about 75% by weight of a polypropylene glycol and/or polyoxypropylene glycol flexibilizer, about 0.85% to about 1% by weight of a tertiary amine (e.g., trimethyl amine), and a minor amount of hexahydrophthalic acid resulting from hydrolysis of the corresponding anhydride. The coloring agent employed is generally a mixture of chlorinated copper phthalocyanine on a titanium dioxide pigment. The filler, zinc oxide, is added to complete the composition. Adhesive 51 is used to the extent that it defines a thick interface between elements 33 and 37. By the term thick is meant an interface having a thickness within the range of about 76,2 μm (0.003 inch) to about 228,6 μm (0.009 inch). This thickness is represented by the letter "a" in FIG. 2. Use of the aforementioned material at the thickness defined herein greatly facilitates assembly of the invention (by reducing dimensioned tolerances), particularly regarding the attachment of the invention's heat spreader and heat sink elements.

As stated, heat transference along the invention's second interface is not critical at this location because of the relatively (compared to the size of the invention's chip) large size of the heat spreader. Thus a lower thermal conductivity is possible, as determined by the formula

$$R_T = \frac{L}{KA},$$

wherein R_T equals the thermal resistance (across the interface), L equals the length of the heat path across the spreader's width, K equals the adhesive's thermal conductivity, and A is the cross-sectional area (of the adhesive). Using the aforementioned materials and corresponding thicknesses (see also below), a thermal resistance within the range of about 0.05°C/Watt to about 0.5°C/Watt across the second interface was measured. This is slightly higher than the thermal resistance (about 0.03°C/Watt to about 0.15°C/Watt) across the invention's first interface (wherein heat transference is deemed critical).

When using an adhesive 51 having a thickness defined above, the corresponding thicknesses for the heat spreader 37 (dimension "b" in FIG. 2) is preferably within the range of about 63,5 μm (0.0025) to about 139,7 μm (0.0055 inch) while that of the corresponding adhesive 41 was within the range of about 25,4 μm 0.001) to about 76,2 μm (0.003 inch) (the device 17 having a thickness of about 63,5 μm (0.0025 inch)). It is of course understood that both adhesives used in the invention's two interfaces solidify (become rigid) upon curing thereof.

Assembly of the invention is accomplished by firstly attaching the defined semiconductor device 17 to the flexible circuitized substrate 19. This is first achieved by bonding the aforementioned projecting end portions 27 of the flexible substrate to the respective contact locations of the device. Thereafter, device 17 is secured to heat spreader 37 using the defined adhesive 41. This is readily accomplished, for example, by inverting the heat spreader and precisely aligning the chip thereon. Subsequently, the projecting second end portions 29 of the flexible substrate 19 are attached to the respective circuit elements 15 on substrate 11. This subassembly in position, heat sink 33 is then located atop same and the heat spreader 37 secured to substrate 11. This may be achieved by positioning the aforementioned adhesive 51 on the under surface of the heat sink or on the heat spreader's upper surface as illustrated in FIG. 1. Alternatively, adhesive can be applied to both of these surfaces.

Assembly of the heat sink to the heat spreader and substrate 11 is facilitated through the provision of curved lower leg segments 53 for the heat sink. Such curved segments are illustrated in FIG. 4 and enable the heat sink to be depressed downward to facilitate the defined contact with the heat spreader of the invention. That is, the heat sink can be depressed to the extent that effective contact with the heat spreader is assured while enabling the heat sink to return to the desired fully upright position (e.g., as shown in FIG. 1).

In FIG. 3, there is shown an electronic package 60 in accordance with an alternative embodiment of the invention. Specifically, the defined heat spreader 67 as used therein and the shown heat sink 73 possess matching curvilinear surfaces in order to provide a curvilinear interface at this juncture. Materials for these components as taught above may be utilized, including the defined adhesive (not shown) along this now greatly extended second interface. The configuration as depicted in FIG. 3 provides even greater heat escapement through the use of such an extended surface area between the two major heat dissipating components of the invention. Assembly of this embodiment of the invention can be accomplished in substantially the same manner as that defined for the embodiment in FIG. 1.

In summary, there has been provided an electronic package which greatly promotes heat removal therefrom, thus enabling the utilization of high circuit densities as are required in many of today's electronic packages. As defined, the invention combines the use of a thin film, flexible circuitized substrate with an effective heat spreader component to provide a sound means for heat transfer between the invention's heat-generating semiconductor device (e.g., chip) and corresponding heat sink members. The invention accomplishes this ef-

fective heat transfer through the use of a large heat spreader possessing a low coefficient of thermal expansion and a relatively high thermal conductivity. In addition, an adhesive also possessing a low coefficient of thermal expansion and corresponding high thermal conductivity is also used to interconnect the device and heat spreader component. As defined herein, the unique arrangement of the invention also greatly facilitates assembly of such a package and thus renders the invention readily adaptable to mass production.

Claims

1. Electronic package (10) having
a circuitized substrate (11),
a semiconductor device (17) positioned at a spaced elevation above the upper surface of said circuitized substrate (11) and electronically coupled thereto, a heat sink (33) for providing heat escape from said package and a heat spreader (37) for providing an enhanced heat path from said semiconductor device to said heat sink, said heat spreader (37) being secured to said semiconductor device and said heat sink by an adhesive, wherein the coefficients of thermal expansion of said semiconductor device (17) and said heat spreader (37) are matched and for said positioning of the semiconductor device (17) a circuitized substrate (19) of flexible nature is electrically connected to said circuitized substrate (11) and said semiconductor device (17), said flexible substrate (19) comprising a thin, electrically insulative material (23), preferably a polymer, having a defined pattern of electrical circuitry (25) thereon, characterized in that the coefficients of thermal expansion of said adhesive used to secure said heat spreader (37) to said semiconductor device (17) is matched to the thermal expansion coefficients of said heat spreader (37) and said semiconductor device (17) and in that the heat sink (33) is connected to the circuitized substrate (11) by curved legs (53).

2. Electronic package according to claim 1 wherein the coefficients of thermal expansion of the semiconductor device (17), the heat spreader (37), and said adhesive used between these parts are within the range of from 2.0 to 5.0 ppm/degree Celsius (x 10^{-6} m/m degrees Kelvin), preferably the coefficients of thermal expansion of the semiconductor device (17) and the heat spreader (37) are each 2.5 ppm/degree Celsius (x 10^{-6} m/m degrees Kelvin) and the coefficient of thermal expansion of said adhesive used between those parts is 3 ppm/degree Celsius (x 10^{-6} m/m degrees Kelvin).

3. Electronic package according to claim 2 wherein the heat spreader (37) is comprised of a metallic material, preferably copper-clad Invar.

4. Electronic package according to claim 2 or 3 wherein the material of the heat spreader (37) is selected from the group consisting of silicon carbide and aluminum nitride.

5. Electronic package according to one of the preceding claims 2 to 4 wherein said adhesive used along a first interface (41) between the semiconductor device (17) and the heat spreader (37) is electrically insulative, preferably diamond-filled epoxy.

6. Electronic package according to one of the preceding claims wherein the heat sink (33) is metallic, preferably selected from the group consisting of aluminum and copper.

7. Electronic package according to one of the preceding claims wherein the overall outer surface area of the heat spreader (37) is at least twice the overall outer surface area of the semiconductor device (17).

8. Electronic package according to one of the preceding claims wherein the adhesive used along a second interface (51) between the heat spreader (37) and the heat sink (33) has a thickness of 76,2 um to about 228,6 um and the adhesive used along the first interface (41) between the semiconductor device (17) and the heat spreader (37) has a thickness of 25,4 µm to 76,2 µm.

9. Electronic package according to claim 8 wherein the adhesive used along the interface (51) between the heat spreader (37) and the heat sink (33) is an epoxy having a thermally conductive filler, preferably zinc oxide, as part thereof.

10. Electronic package according to one of the preceding claims wherein said second interface (51) between

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fective heat transfer through the use of a large heat spreader possessing a low coefficient of thermal expansion and a relatively high thermal conductivity. In addition, an adhesive also possessing a low coefficient of thermal expansion and corresponding high thermal conductivity is also used to interconnect the device and heat spreader component. As defined herein, the unique arrangement of the invention also greatly facilitates assembly of such a package and thus renders the invention readily adaptable to mass production.

Claims

1. Electronic package (10) having
a circuitized substrate (11),
a semiconductor device (17) positioned at a spaced elevation above the upper surface of said circuitized substrate (11) and electronically coupled thereto, a heat sink (33) for providing heat escape from said package and a heat spreader (37) for providing an enhanced heat path from said semiconductor device to said heat sink, said heat spreader (37) being secured to said semiconductor device and said heat sink by an adhesive, wherein the coefficients of thermal expansion of said semiconductor device (17) and said heat spreader (37) are matched and for said positioning of the semiconductor device (17) a circuitized substrate (19) of flexible nature is electrically connected to said circuitized substrate (11) and said semiconductor device (17), said flexible substrate (19) comprising a thin, electrically insulative material (23), preferably a polymer, having a defined pattern of electrical circuitry (25) thereon, characterized in that the coefficients of thermal expansion of said adhesive used to secure said heat spreader (37) to said semiconductor device (17) is matched to the thermal expansion coefficients of said heat spreader (37) and said semiconductor device (17) and in that the heat sink (33) is connected to the circuitized substrate (11) by curved legs (53).

2. Electronic package according to claim 1 wherein the coefficients of thermal expansion of the semiconductor device (17), the heat spreader (37), and said adhesive used between these parts are within the range of from 2.0 to 5.0 ppm/degree Celsius (x 10^{-6} m/m degrees Kelvin), preferably the coefficients of thermal expansion of the semiconductor device (17) and the heat spreader (37) are each 2.5 ppm/degree Celsius (x 10^{-6} m/m degrees Kelvin) and the coefficient of thermal expansion of said adhesive used between those parts is 3 ppm/degree Celsius (x 10^{-6} m/m degrees Kelvin).

3. Electronic package according to claim 2 wherein the heat spreader (37) is comprised of a metallic material, preferably copper-clad Invar.

4. Electronic package according to claim 2 or 3 wherein the material of the heat spreader (37) is selected from the group consisting of silicon carbide and aluminum nitride.

5. Electronic package according to one of the preceding claims 2 to 4 wherein said adhesive used along a first interface (41) between the semiconductor device (17) and the heat spreader (37) is electrically insulative, preferably diamond-filled epoxy.

6. Electronic package according to one of the preceding claims wherein the heat sink (33) is metallic, preferably selected from the group consisting of aluminum and copper.

7. Electronic package according to one of the preceding claims wherein the overall outer surface area of the heat spreader (37) is at least twice the overall outer surface area of the semiconductor device (17).

8. Electronic package according to one of the preceding claims wherein the adhesive used along a second interface (51) between the heat spreader (37) and the heat sink (33) has a thickness of 76,2 um to about 228,6 um and the adhesive used along the first interface (41) between the semiconductor device (17) and the heat spreader (37) has a thickness of 25,4 µm to 76,2 µm.

9. Electronic package according to claim 8 wherein the adhesive used along the interface (51) between the heat spreader (37) and the heat sink (33) is an epoxy having a thermally conductive filler, preferably zinc oxide, as part thereof.

10. Electronic package according to one of the preceding claims wherein said second interface (51) between

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said heat sink (33) and said heat spreader (37) is curvilinear in shape.

Patentansprüche

1. Elektronische Packung (10) mit
einem beschalteten Substrat (11),
einem Halbleiterbauelement (17), das sich in erhöhter Position im Abstand zur oberen Oberfläche des beschalteten Substrates (11) befindet und elektronisch damit verbunden ist, einem Kühlkörper (33) zur Bereitstellung einer Wärmeabführung aus dem Bauelement und einem Wärmeableiter (37) zur Bereitstellung eines verbesserten Wärmeweges von den Halbleiterbauelementen zum Kühlkörper, wobei der Wärmeableiter (37) auf dem Halbleiterbauelement und dem Kühlkörper durch einen Kleber befestigt ist, wobei die thermischen Ausdehnungskoeffizienten des Halbleiterbauelementes (17) und des Wärmeableiters (37) miteinander übereinstimmen und womit das Positionieren des Halbleiterbauelementes (17) ein flexibles beschaltetes Substrat (19) elektrisch mit dem beschalteten Substrat (11) und dem Halbleiterbauelement (17) verbindet, wobei das flexible Substrat (19) ein dünnes elektrisch leitendes Material (23) umfaßt, vorzugsweise einen Polymer, das auf sich ein definiertes Muster einer elektrischen Schaltung (25) trägt, dadurch gekennzeichnet, daß die thermischen Ausdehnungskoeffizienten des Klebers, der zur Befestigung des Wärmeableiters (37) auf des Halbleiterbauelementes (17) dient, mit den thermischen Ausdehnungskoeffizienten des Wärmeableiters (37) und des Halbleiterbauelementes (17) zusammenpassen und dadurch, daß der Kühlkörper (33) durch gebogene Fußteile (53) mit dem beschalteten Substrat (11) verbunden ist.

2. Elektronische Packung gemäß Anspruch 1, wobei die thermischen Ausdehnungskoeffizienten des Halbleiterbauelementes (17), des Wärmeableiters (37) und des zwischen diesen Teilen verwendeten Klebers sich innerhalb eines Bereiches von 2,0 bis 5,0 ppm/Grad Celsius (x 10^{-6} mm pro Grad Kelvin) befinden, wobei die thermischen Ausdehnungskoeffizienten des Halbleiterbauelementes (17) und des Wärmeableiters (37) vorzugsweise jeweils 2,5 ppm/Grad Celsius (x 10^{-6} mm pro Grad Kelvin) und der thermische Ausdehnungskoeffizient des zwischen diesen Teilen verwendeten Klebers gleich 3 ppm/Grad Celsius (x 10^{-6} mm pro Grad Kelvin) ist.

3. Elektronische Packung gemäß Anspruch 2, wobei der Wärmeableiter (37) aus einem metallischen Material besteht, vorzugsweise aus kupferplattiertem Invar.

4. Elektronische Packung gemäß Anspruch 2 oder 3, wobei das Material des Wärmeableiters (37) aus einer Gruppe ausgewählt wird, die aus Siliciumcarbid und Aluminiumnitrid besteht.

5. Elektronische Packung gemäß einem der vorhergehenden Ansprüche 2 bis 4, wobei der entlang einer ersten Grenzfläche (41) zwischen dem Halbleiterbauelement (17) und dem Wärmeableiter (37) benutzte Kleber elektrisch isolierend ist, vorzugsweise Epoxidharz mit Diamantfüllstoff.

6. Elektronische Packung gemäß einem der vorhergehenden Ansprüche, wobei der Kühlkörper (33) metallisch ist, vorzugsweise ausgewählt aus einer Gruppe, die aus Aluminium und Kupfer besteht.

7. Elektronische Packung gemäß einem der vorhergehenden Ansprüche, wobei der gesamte äußere Oberflächenbereich des Wärmeableiters (37) mindesten das Doppelte des gesamten äußeren Oberflächenbereiches des Halbleiterbauelementes (17) beträgt.

8. Elektronische Packung gemäß einem der vorhergehenden Ansprüche, wobei der entlang einer zweiten Grenzfläche (51) zwischen dem Wärmeableiter (37) und dem Kühlkörper (33) verwendete Kleber eine Dicke von 76,2 bis etwa 228,6 µm hat und der entlang der ersten Grenzfläche (41) zwischen dem Halbleiterbauelement (17) und dem Wärmeableiter (37) verwendete Kleber eine Dicke von 25,4 bis 76,2 µm hat.

9. Elektronische Packung gemäß Anspruch 8, wobei der entlang der Grenzfläche (51) zwischen dem Wärmeableiter (37) und dem Kühlkörper (33) verwendete Kleber ein Epoxidharz mit einem thermisch leitenden Füllstoff als seinem Bestandteil ist, vorzugsweise Zinkoxid.

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10. Elektronische Packung gemäß einem der vorhergehenden Ansprüche, wobei die zweite Grenzfläche (51) zwischen dem Kühlkörper (33) und dem Wärmeableiter (37) von krummliniger Gestalt ist.

Revendications

1. Ensemble électronique ayant:
un substrat de circuit (11)
un dispositif semiconducteur (17) espacé en élévation au-dessus de la surface supérieure dudit substrat de circuit (11) et lui étant électroniquement couplé, un élément de dissipation de chaleur (33) pour assurer un dégagement de chaleur à partir dudit ensemble et un élément de propagation de chaleur (37) pour assurer un trajet de chaleur renforcé depuis ledit dispositif semiconducteur jusqu'audit élément de dissipation de chaleur, ledit élément de propagation de chaleur (37) étant fixé audit dispositif semiconducteur et audit élément de dissipation de chaleur par un adhésif, dans lequel les coefficients de dilatation thermique dudit dispositif semiconducteur (17) et dudit élément de propagation de chaleur (37) concordent et, pour ledit positionnement du dispositif semiconducteur (17), un substrat de circuit (19) de nature souple est électriquement connecté audit substrat de circuit (11) et audit dispositif semiconducteur (17), ledit substrat souple 19 comprenant un matériau électriquement isolant, mince (23), de préférence un polymère, sur lequel est définie une configuration de circuit électrique (25), caractérisé en ce que les coefficients de dilatation thermique dudit adhésif utilisé pour fixer ledit élément de propagation de chaleur (37) audit dispositif semiconducteur (17) concordent avec les coefficients de dilatation thermiques dudit élément de propagation de chaleur (37) et dudit dispositif semiconducteur (17), et en ce que l'élément de dissipation de chaleur (33) est connecté au substrat de circuit (11) par des segments curvilignes (53).

2. Ensemble électronique selon la revendication 1, dans lequel les coefficients de dilatateur thermique du dispositif semiconducteur (17), de l'élément de propagation de chaleur (37) et dudit adhésif utilisé entre ces pièces sont dans la plage allant de 2,0 à 5,0 ppm/degré Celsius (x 10^{-6} m/m degrés Kelvin), de préférence, les coefficients de dilatation thermique du dispositif semiconducteur (17) et de l'élément de propagation de chaleur (37) étant chacun à 2,5 ppm/degré Celsius (x 10^{-6} m/m degrés Kelvin), et le coefficient de dilatation thermique dudit adhésif utilisé entre ces pièces est de 3 ppm/degré Celsius (x 10^{-6} m/m degrés Kelvin).

3. Ensemble électronique selon la revendication 2, dans lequel l'élément de propagation de chaleur (37) est constitué d'un matériau métallique, de préférence, de l'Invar revêtu de cuivre.

4. Ensemble électronique selon les revendication 2 ou 3, dans lequel le matériau de l'élément de propagation de chaleur (37) est sélectionné dans le groupe constitué de carbure de silicium et de nitrure d'aluminium.

5. Ensemble électronique selon l'une quelconque des revendications précédentes 2 à 4, dans lequel ledit adhésif utilisé le long d'une première interface (41) séparant le dispositif semiconducteur (17) et l'élément de propagation de chaleur (37), est électriquement isolant, de préférence, un matériau époxy rempli de diamant.

6. Ensemble électronique selon l'une quelconque des revendications précédentes, dans lequel l'élément de dissipation de chaleur (33) est métallique, de préférence, sélectionné dans le groupe constitué d'aluminium et de cuivre.

7. Ensemble électronique selon l'une quelconque des revendications précédentes, dans lequel la région de surface externe totale de l'élément de propagation de chaleur (37) est au moins le double de la région de surface externe totale du dispositif semiconducteur (17).

8. Ensemble électronique selon l'une quelconque des revendications précédentes, dans lequel l'adhésif utilisé le long d'une deuxième interface (51) séparant l'élément de propagation de chaleur (37) et l'élément de dissipation de chaleur (33) a un épaisseur allant de 76,2 µm à environ 228,6 µm, et l'adhésif utilisé le long de la première interface (41) séparant le dispositif semiconducteur (17) et l'élément de propagation de chaleur (37) a une épaisseur allant de 25,4 µm à 76,2 µm.

9. Ensemble électronique selon la revendication 8, dans lequel l'adhésif utilisé le long de l'interface (51) sé-

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parant l'élément de propagation de chaleur (37) et l'élément de dissipation de chaleur (33) est un matériau époxy ayant un agent de remplissage thermiquement conducteur, de préférence, un oxyde de zinc, comme faisant partie de lui-même.

10. Ensemble électronique selon l'une quelconque des revendications précédentes, dans lequel ladite deuxième interface (51) séparant ledit élément de dissipation de chaleur (33) et ledit élément de propagation de chaleur (37) est de forme curviligne.