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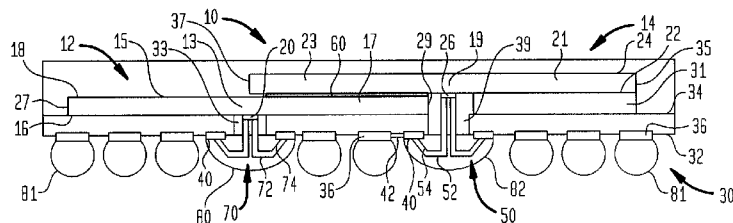
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FIG. 1



(57) Abstract: A microelectronic assembly includes a dielectric element 930B having oppositely-facing first and second surfaces and one or more apertures 972 extending between the surfaces, the dielectric element further having conductive elements thereon; a first microelectronic element 900A having a rear surface and a front surface facing the first surface of the dielectric element 930B, the first microelectronic element 900A having a first edge and a plurality of contacts exposed at the front surface thereof; a second microelectronic element 900B including having a rear surface and a front surface facing the rear surface of the first microelectronic element 900A, a projecting portion of the front surface of the second microelectronic element 900B extending beyond the first edge of the first microelectronic element 900A, the projecting portion being spaced from the first surface of the dielectric element 930B, the second microelectronic element 900B having a plurality of contacts exposed at the projecting portion of the front surface; leads extending from contacts of the microelectronic elements through the at least one aperture to at least some of the conductive elements; and a heat spreader 970 thermally coupled to at least one of the first microelectronic element 900A or the second microelectronic element 900B.

ENHANCED STACKED MICROELECTRONIC ASSEMBLIES

WITH CENTRAL CONTACTS AND IMPROVED THERMAL CHARACTERISTICS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation of U.S. Patent Application No. 12/907,522, filed on October 19, 2010, the disclosure of which is hereby incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to stacked microelectronic assemblies and methods of making such assemblies, and to components useful in such assemblies.

[0003] Semiconductor chips are commonly provided as individual, prepackaged units. A standard chip has a flat, rectangular body with a large front face having contacts connected to the internal circuitry of the chip. Each individual chip typically is mounted in a package which, in turn, is mounted on a circuit panel such as a printed circuit board and which connects the contacts of the chip to conductors of the circuit panel. In many conventional designs, the chip package occupies an area of the circuit panel considerably larger than the area of the chip itself. As used in this disclosure with reference to a flat chip having a front face, the "area of the chip" should be understood as referring to the area of the front face. In "flip chip" designs, the front face of the chip confronts the face of a package substrate, i.e., chip carrier and the contacts on the chip are bonded directly to contacts of the chip carrier by solder balls or other connecting elements. In turn, the chip carrier can be bonded to a circuit panel through terminals overlying the front face of the chip. The "flip chip" design provides a relatively compact arrangement; each chip occupies an area of the circuit panel equal to or slightly larger than the area of the chip's front face, such as disclosed, for example, in certain embodiments of commonly-assigned U.S. Pat. Nos. 5,148,265; 5,148,266; and 5,679,977, the disclosures of which are incorporated herein by reference.

[0004] Certain innovative mounting techniques offer compactness approaching or equal to that of conventional flip-chip bonding. Packages which can accommodate a single chip in an area of the circuit panel equal to or slightly larger than the area of the chip itself are commonly referred to as "chip-sized packages."

[0005] Besides minimizing the planar area of the circuit panel occupied by microelectronic assembly, it is also desirable to produce a chip package that presents a low, overall height or dimension perpendicular to the plane of the circuit panel. Such thin microelectronic packages allow for placement of a circuit panel having the packages mounted therein in close proximity to neighboring structures, thus producing the overall size of the product incorporating the circuit panel. Various proposals have been advanced for providing plural chips in a single package or module. In the conventional "multi-chip module", the chips are mounted side-by-side on a single package substrate, which in turn can be mounted to the circuit panel. This approach offers only limited reduction in the aggregate area of the circuit panel occupied by the chips. The aggregate area is still greater than the total surface area of the individual chips in the module.

[0006] It has also been proposed to package plural chips in a "stack" arrangement i.e., an arrangement where plural chips are placed one on top of another. In a stacked arrangement, several chips can be mounted in an area of the circuit panel that is less than the total area of the chips. Certain stacked chip arrangements are disclosed, for example, in certain embodiments of the aforementioned U.S. Pat. Nos. 5,679,977; 5,148,265; and U.S. Pat. No. 5,347,159, the disclosure of which is incorporated herein by reference. U.S. Pat. No. 4,941,033, also incorporated herein by reference, discloses an arrangement in which chips are stacked on top of another and interconnected with one another by conductors on so-called "wiring films" associated with the chips.

[0007] Despite these efforts in the art, further improvements would be desirable in the case of multi-chip packages for chips having contacts located substantially in central regions of the chips. Certain semiconductor chips, such as some memory chips, are commonly made with the contacts in one or two rows located substantially along a central axis of the chip.

BRIEF SUMMARY OF THE INVENTION

[0008] A microelectronic assembly includes a dielectric element having oppositely-facing first and second surfaces and one or more apertures extending between the surfaces, the dielectric element further having conductive elements thereon; a first microelectronic element having a rear surface and a front surface facing the first surface of the dielectric element, the first microelectronic element having a first edge and a plurality of contacts exposed at the front surface thereof; a second microelectronic element including having a rear surface and a front surface facing the rear surface of the first microelectronic element, a projecting portion of the front surface of the second microelectronic element extending beyond the first edge of the first microelectronic element, the projecting portion being spaced from the first surface of the dielectric element, the second microelectronic element having a plurality of contacts exposed at the projecting portion of the front surface; leads extending from contacts of the microelectronic elements through the at least one aperture to at least some of the conductive elements; and a heat spreader thermally coupled to at least one of the first microelectronic element or the second microelectronic element.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a diagrammatic sectional elevation view of a stacked microelectronic assembly according to an embodiment of the present invention;

[0010] FIG. 2 is a bottom view of the stacked assembly of FIG. 1;

[0011] FIG. 3 is a diagrammatic sectional view of a stacked microelectronic arrangement according to another embodiment of the present invention;

[0012] FIG. 4 is a diagrammatic sectional view of a stacked microelectronic assembly according to another embodiment of the present invention; and

[0013] FIG. 5 is a diagrammatic sectional view of a stacked microelectronic assembly according to yet another embodiment of the present invention;

[0014] FIG. 6 is a diagrammatic sectional view of a stacked microelectronic assembly according to an embodiment of the present invention;

[0015] FIG. 7 is a schematic depiction of a system according to one embodiment of the invention.

DETAILED DESCRIPTION

[0016] With reference to FIG. 1, a stacked microelectronic assembly 10 according to an embodiment of the present invention includes a first microelectronic element 12 and a second microelectronic element 14. In some embodiments, the first and second microelectronic elements 12 and 14 may be a semiconductor chip, a wafer, or the like.

[0017] The first microelectronic element 12 has a front surface 16, a rear surface 18 remote therefrom, and first and second edges 27, 29, extending between the front and rear surfaces. The front surface 16 of the first microelectronic element 12 includes first and second end regions 15 and 17 and a central region 13 located between the first and second end regions 15 and 17. The first end region 15 extends between the central region 13 and first edge 27, and the second end region 17 extends between the central region 13 and the second edge 29. Electrical contacts 20 are exposed at the front surface 16 of the first microelectronic element 12. As used in this disclosure, a statement that an electrically conductive element is "exposed at" a surface of a structure indicates that the electrically conductive element is available for contact with a theoretical point

moving in a direction perpendicular to the surface toward the surface from outside the structure. Thus, a terminal or other conductive element which is exposed at a surface of a structure may project from such surface; may be flush with such surface; or may be recessed relative to such surface and exposed through a hole or depression in the structure. The contacts 20 of the first microelectronic element 12 are exposed at the front surface 16 within the central region 13. For example, contacts 20 may be arranged in one or two parallel rows adjacent the center of first surface 16.

[0018] The second microelectronic element 14 has a front surface 22, a rear surface 24 remote therefrom, and first and second edges 35, 37, extending between the front and rear surfaces. The front surface 22 of the second microelectronic element 14 includes first and second end regions 21 and 23 and a central region 19 located between the first and second end regions 21 and 23. The first end region 21 extends between the central region 19 and first edge 35, and the second end region 23 extends between the central region 19 and the second edge 37. Electrical contacts 26 are exposed at the front surface 22 of the second microelectronic element 14. The contacts 26 of the second microelectronic element 14 are exposed at the front surface 22 within the central region 19. For example, contacts 26 may be arranged in one or two parallel rows adjacent the center of first surface 22.

[0019] As seen in Figure 1, the first and second microelectronic elements 12 and 14 are stacked relative to each other. In some embodiments, the front surface 22 of the second microelectronic element 14 and the rear surface 18 of the first microelectronic element 12 face each other. At least a portion of the second end region 23 of the second microelectronic element 14 overlies at least a portion of the second end region 17 of the first microelectronic element 12. At least a portion of the central region 19 of the second microelectronic element 14 projects beyond the second edge 29 of the first microelectronic element 12. Accordingly, the

contacts 26 of the second microelectronic element 14 are positioned in a location beyond the second edge 29 of the first microelectronic element 12.

[0020] The microelectronic assembly 10 further includes a dielectric element 30 having oppositely-facing first and second surfaces 32 and 34. While Figure 1 shows only one dielectric element 30, the microelectronic assembly 10 may include more than one dielectric element. One or more electrically conductive elements or terminals 36 are exposed at the first surface 32 of the dielectric element 30. At least some terminals 36 may be movable with respect to the first and/or second microelectronic element 12 and 14.

[0021] The dielectric element 30 may further include one or more apertures. In the embodiment depicted in Figure 1, the dielectric element 30 includes a first aperture 33 substantially aligned with the central region 13 of the first microelectronic element 12 and a second aperture 39 substantially aligned with the central region 19 of the second microelectronic element 14, thereby providing access to contacts 20 and 26.

[0022] As seen in Figure 1, the dielectric element 30 may extend beyond the first edge 27 of the first microelectronic element 12 and the second edge 35 of the second microelectronic element 14. The second surface 34 of the dielectric element 30 may be juxtaposed with the front surface 16 of the first microelectronic element 12. The dielectric element 30 may be partly or entirely made of any suitable dielectric material. For example, the dielectric element 30 may comprise a layer of flexible material, such as a layer of polyimide, BT resin or other dielectric material of the commonly used for making tape automated bonding ("TAB") tapes. Alternatively, the dielectric element 30 may comprise a relatively rigid, board like material such as a thick layer of fiber-reinforced epoxy, such as, Fr-4 or Fr-5 board. Regardless of the material employed, the dielectric

element 30 may include a single layer or multiple layers of dielectric material.

[0023] The dielectric element 30 may also include electrically conductive elements 40 exposed on the first surface 32 and electrically conductive traces 42. The electrically conductive traces 42 electrically couple the electrically conductive elements 40 to the terminals 36.

[0024] A spacing or support element 31, such as an adhesive layer, may be positioned between the first end region 21 of the second microelectronic element 14 and a portion of the dielectric element 30. If spacing layer 31 includes an adhesive, the adhesive can connect the second microelectronic element 14 to the dielectric element 30. Another spacing layer 60 may be positioned between the second end region 23 of the second microelectronic element 14 and the second end region 17 of the first microelectronic element 12. This spacing layer 60 may include adhesive for bonding the first and second microelectronic elements 12 and 14 together. In such case, the spacing layer 60 may be partly or entirely made of a die-attach adhesive and may be comprised of a low elastic modulus material such as silicone elastomer. However, the spacing layer 60 may be entirely or partly made of a thin layer of high elastic modulus adhesive or solder if the two microelectronic elements 12 and 14 are conventional semiconductor chips formed of the same material, because the microelectronic elements will tend to expand and contract in unison in response to temperature changes. Irrespective of the materials employed, each of spacing layers 31 and 60 may include a single layer or multiple layers.

[0025] As seen in FIGS. 1 and 2, electrical connections or leads 70 electrically connect contacts 20 of the first microelectronic element 12 to some electrically conductive elements 40 on the dielectric element 30. Electrical connections 70 may include multiple wire bonds 72, 74 electrically connecting a contact of microelectronic element

12 with a conductive element 40. Wire bonds 72, 74 extend through the first aperture 33 and are oriented substantially parallel to each other. Each of the wire bonds 72 and 74 electrically couples a contact 20 to a corresponding conductive element 40 of the dielectric element. A multiple wire bond structure according to this embodiment can substantially decrease inductance of a wire bond connection by providing an additional path for current to flow between the connected contacts.

[0026] Other electrical connections or leads 50 electrically couple contacts 26 of the second microelectronic element 14 to some conductive elements 40. Electrical connections 50 may include multiple wire bonds 52, 54 electrically connecting a contact of microelectronic element 14 with a conductive element 40. Wire bonds 52, 54 extend through the second aperture 39 and are oriented substantially parallel to each other. Both wire bonds 52 and 54 electrically couple a contact 26 to a corresponding element 40 of the dielectric element 30. A multiple bond wire structure according to this embodiment can substantially decrease inductance of a wire bond connection by providing an additional path for current to flow between the connected contacts.

[0027] The microelectronic assembly 10 further includes an overmold 11 covering at least the first microelectronic element 12 and the second microelectronic element 14. As seen in FIG. 1, the overmold 11 may also cover portions of the dielectric element 30 extending beyond the first edge 27 of the first microelectronic element 12 and the first edge 35 of the second microelectronic element 14.

[0028] FIG. 3 depicts an arrangement 1000 including at least two stacked and electrically interconnected microelectronic assemblies 900. Microelectronic assemblies 900A and 900B may be any of the assemblies described above. At least one of the microelectronic assemblies may have conductive joining units attached to

terminals thereof, such as solder balls 981 or other masses of bond and metal, e.g., tin, indium, or a combination thereof. The two microelectronic assemblies 900 are electrically connected to each other through any suitable electrically conductive connections. For example, the assemblies can be electrically interconnected via solder columns 990 which are joined to pads (not shown) on the dielectric elements 930A, 930B of the respective microelectronic elements. In a particular embodiment also shown in FIG. 3, electrically conductive posts 992 and solder 994 can be used to electrically interconnect the two microelectronic assemblies 900A and 900B. Posts 992 may extend either from the first assembly or from the second assembly towards the other, or posts provided on both assemblies may extend towards each other.

[0029] With continued reference to FIG. 3, a heat spreader 970 can be disposed between the first and second microelectronic assemblies 900A and 900B to help distribute heat evenly within the arrangement of stacked microelectronic assemblies. The heat spreader 970 may also improve heat dissipation to the surrounding environment. The heat spreader may be partly or entirely made of any suitable thermally conductive material. Examples of suitable thermally conductive material include, but are not limited to, metal, graphite, thermally-conductive adhesives, e.g., thermally-conductive epoxy, a solder, or the like, or a combination of such materials. In one example, the heat spreader can be a substantially continuous sheet of metal. In a particular embodiment, a pre-formed heat spreader 970 made of metal or other thermally conductive material may be attached to or disposed on the front surface 932B of the dielectric element 930B of the second microelectronic assembly 900B such as with a thermally conductive material such as a thermally conductive adhesive or thermally conductive grease. The adhesive if present, can be a compliant material which permits relative movement between

the heat spreader and the microelectronic element or dielectric element to which it is attached, such as to accommodate differential thermal expansion between the compliantly attached elements. The heat spreader 970 may be a monolithic structure and may include one or more apertures 972, 974 substantially aligned with the apertures 933B, 939B of the dielectric element 930B, respectively. In one embodiment, each of the apertures 972, 974 of the heat spreader 970 may be dimensioned to receive the encapsulant 980B or 982B covering the aperture 933B or 939B of the dielectric element 930B. Alternatively, the heat spreader 970 may include multiple spreader portions spaced apart from one another. Although not shown, the heat spreader 970 may alternatively be attached to the rear surface 924A of the second microelectronic element 914A of microelectronic assembly 900A to the rear surface 918A of the first microelectronic element 912A of the first microelectronic assembly 900A, or to the rear surfaces of both microelectronic elements 912A, 914A. In a particular embodiment, the heat spreader may be or include a layer of solder joined directly to at least a portion of a rear surface of one or more of the first and second microelectronic elements 912A, 914A.

[0030] In any of the embodiments described herein, the microelectronic assembly may include additional heat spreaders disposed in other locations of the microelectronic assemblies.

[0031] FIG. 4 shows a microelectronic assembly 1200, as described above, including a heat spreader 1280 attached at least to the rear surface 1224 of the second microelectronic element 1214. The heat spreader 1280 may be in thermally conductive communication with the entire rear surface 1224 of the second microelectronic assembly 1214 and may extend beyond the first and second edges 1235, 1237 of the second microelectronic element. A support element 1290 may be made of silicon or any other suitable material and may be disposed

between the heat spreader 1280 and the first end region 1215 of the first microelectronic element 1212. The support element can be made of thermally conductive material, such as metal, a metal-filled polymer material, e.g., conductive epoxy, graphite, adhesive, solder or any material suitable to improve heat transfer and dissipation within the assembly and between the assembly and the environment.

[0032] Another support element 1292 may be disposed between the first end region 1221 of the second microelectronic element 1214 and the dielectric element 1230. Support element 1292 may be partly or entirely made of silicon. The heat spreader 1280 may extend beyond the first and second edges 1227, 1229 of the first microelectronic element. As discussed above, the heat spreader 1280 may be entirely or partly made of metal, graphite, or any other suitable thermally conductive material and may be attached to or in thermal communication with other parts of the assembly through a thermally conductive adhesive which can be compliant or a thermally conductive grease. In one embodiment, particularly when the microelectronic elements consist essentially of one type of semiconductor materials, e.g., silicon, the support elements 1290, 1292 can consist essentially of the same semiconductor material.

[0033] In addition to the heat spreader 1280, the microelectronic assembly 1200 may include one or more thermally conductive balls 1282, 1284. The balls 1282, 1284 typically are made of solder, but may include a core of thermally conductive metal such as copper balls therein or copper posts, as illustrated at 1283. Thermally conductive balls 1282 may be attached to the front surface 1232 of the dielectric element 1230 in substantial alignment with the first edge 1227 of the first microelectronic element 1212. A thermally conductive connector 1286 may be attached to one or more thermally conductive balls 1282 and may extend through the dielectric element 1230. The thermally conductive balls 1284 may be attached to the front surface 1232 of the

dielectric element 1230 in substantial alignment with the first edge 1235 of the second microelectronic element 1214. A thermally conductive connector 1288 may be attached to one or more thermally conductive balls 1284 and may extend through the dielectric element 1230.

[0034] FIG. 5 shows a variation of the embodiment depicted in FIG. 4. In this variation, the microelectronic assembly 1300 does not need to include a support element between the first end region 1315 of the first microelectronic 1314 and the heat spreader 1380. The heat spreader 1380 may include a step 1398 adjacent the second edge 1337 of the second microelectronic element 1314. The step 1398 enables the heat spreader 1380 to contact, or at least be in close proximity to, the rear surface 1318 of the first microelectronic element 1312.

[0035] FIG. 6 shows a variation of the embodiment illustrated in FIG. 3. In the variation depicted in FIG. 6, the heat spreader 971 is in thermal communication with the first microelectronic element 912B and the second microelectronic element 914B of microelectronic assembly 900B. The heat spreader 971 may have a first substantially planar surface 987 facing away from rear surfaces 918B and 924B of the first and second microelectronic elements 912B, 914B, respectively. In addition, the heat spreader 971 may have second and third substantially planar surfaces 989A and 989B facing toward the rear surfaces 918B and 924B of the first and second microelectronic elements 912B, 914B, respectively. The heat spreader 971 may include a first portion 973 in thermal communication with and overlying the rear surface 924B of the second microelectronic element 914B and a second portion 975 in thermal communication with and overlying the rear surface 918B of the first microelectronic element 912B. In one specific embodiment, the first portion 973 of heat spreader 971 may be in thermal contact with part or the entire rear surface 924B of the second microelectronic element 914B such as through a solder, thermally conductive

grease or thermally conductive adhesive, for example. Similarly, the second portion 975 of heat spreader 971 may be in thermal contact with part or the entire rear surface 918B of the first microelectronic element 912B. The second portion 975 of the heat spreader 971 may be thicker than the first portion 973.

[0036] With continued reference to FIG. 6, another heat spreader 977 may be in thermal communication with the first microelectronic element 912A and the second microelectronic element 914A of microelectronic assembly 900A. The heat spreader 977 may include a first substantially planar surface 991 facing a way from the first and second microelectronic elements 912A and 914B. Moreover, the heat spreader 977 may include second substantially planar surfaces 993A and 993B facing toward the rear surfaces 918A and 924A of the first and second microelectronic elements 912A, 914A, respectively. In addition, the heat spreader 977 may include a first portion 979 in thermal communication with and overlaying the rear surface 924A of the second microelectronic element 914A and a second portion 983 in thermal communication with and overlaying the rear surface 918A of the first microelectronic element 912A. In one specific embodiment, the first portion 979 of the heat spreader 977 may be in thermal contact with part or the entire rear surface 924A of the second microelectronic element 914A, similar to the arrangement of heat spreader 971. Similarly, the second portion 983 of the heat spreader 977 may be in thermal contact with part or the entire rear surface 918A of the first microelectronic element 912A. The second portion 983 of the heat spreader 977 may be thicker than its first portion 973.

[0037] A thermally conductive material 985 may be disposed between the heat spreader 977 and the dielectric element 930B. The thermally conductive material 985 may include one or more layers of any suitable material and may be between 25 to 100 microns thick. Suitable thermally conductive materials include, but are not limited to, a thermally

conductive grease, solder, indium or any suitable thermally conductive adhesive. The thermally conductive material 985 may be applied to surfaces of one or both of the dielectric element 930B and the heat spreader 977 in liquid or not fully used state. In that way the material can flow into spaces therebetween. Accordingly, the thermally conductive material can conform to variation in height of the surfaces it contacts. In some embodiments, the thermally conductive material 985 may be a monolithic or integral structure including one or more apertures 999 substantially aligned with the contacts 920 and 926 of the first and second microelectronic elements 912B and 914B. Alternatively, the thermally conductive material 985 may include multiple spaced apart and discrete portions. In a particular embodiment, the thermally conductive material 985 can be electrically conductive. In such embodiment, such electrically conductive material could be used as a conductive plane and could be electrically connected to ground. The microelectronic assembly 900A may include a support element 931 between the second microelectronic element 914A and the dielectric element 930A.

[0038] As seen in FIG. 6, any of the microelectronic assemblies described herein may be electronically coupled to a circuit panel or board. For example, microelectronic assembly 500 may include a plurality of joining units, such as solder balls 581 or copper pillars. Solder balls 981 electrically connect microelectronic assembly 900A to circuit panel 1300. While FIG. 6 only shows solder balls 981 connecting microelectronic assembly 500 to circuit panel 1300, it is contemplated that any electrically conductive element may interconnect circuit panel 1300 and microelectronic assembly 900A. One or more electrically conductive elements or terminals 1302 are exposed at the first surface 1304 of the circuit panel 1300. The first surface 1304 of the circuit panel 1300 faces the solder balls 981. Solder balls 981 are attached to terminals 1302 and are

therefore electrically interconnected to at least some of the circuits in circuit panel 1300.

[0039] The microelectronic assemblies described above can be utilized in construction of diverse electronic systems, as shown in FIG. 7. For example, a system 1100 in accordance with a further embodiment of the invention includes a microelectronic assembly 1106 as described above in conjunction with other electronic components 1108 and 1110. In the example depicted, component 1108 is a semiconductor chip whereas component 1110 is a display screen, but any other components can be used. Of course, although only two additional components are depicted in FIG. 24 for clarity of illustration, the system may include any number of such components. The microelectronic assembly 1106 may be any of the assemblies described above. In a further variant, any number of such microelectronic assemblies may be used. Microelectronic assembly 1106 and components 1108 and 1110 are mounted in a common housing 901, schematically depicted in broken lines, and are electrically interconnected with one another as necessary to form the desired circuit. In the exemplary system shown, the system includes a circuit panel 1102 such as a flexible printed circuit board, and the circuit panel includes numerous conductors 1104, of which only one is depicted in FIG. 13, interconnecting the components with one another. However, this is merely exemplary; any suitable structure for making electrical connections can be used. The housing 1101 is depicted as a portable housing of the type usable, for example, in a cellular telephone or personal digital assistant, and screen 1110 is exposed at the surface of the housing. Where structure 1106 includes a light-sensitive element such as an imaging chip, a lens 1111 or other optical device also may be provided for routing light to the structure. Again, the simplified system shown in FIG. 7 is merely exemplary; other systems, including systems commonly regarded as fixed

structures, such as desktop computers, routers and the like can be made using the structures discussed above.

[0040] It will be appreciated that the various dependent claims and the features set forth therein can be combined in different ways than presented in the initial claims. It will also be appreciated that the features described in connection with individual embodiments may be shared with others of the described embodiments.

[0041] Although the invention herein has been described with reference to particular embodiments, it is to be understood that these embodiments are merely illustrative of the principles and applications of the present invention. It is therefore to be understood that numerous modifications may be made to the illustrative embodiments and that other arrangements may be devised without departing from the spirit and scope of the present invention as defined by the appended claims.

CLAIMS

1. A microelectronic assembly comprising:

a dielectric element having oppositely-facing first and second surfaces and one or more apertures extending between the surfaces, the dielectric element further having conductive elements thereon;

a first microelectronic element having a rear surface and a front surface facing the first surface of the dielectric element, the first microelectronic element having a first edge and a plurality of contacts exposed at the front surface thereof;

a second microelectronic element including having a rear surface and a front surface facing the rear surface of the first microelectronic element, a projecting portion of the front surface of the second microelectronic element extending beyond the first edge of the first microelectronic element, the projecting portion being spaced from the first surface of the dielectric element, the second microelectronic element having a plurality of contacts exposed at the projecting portion of the front surface;

leads extending from contacts of the microelectronic elements through the at least one aperture to at least some of the conductive elements; and

a heat spreader thermally coupled to at least one of the first microelectronic element or the second microelectronic element.

2. The microelectronic assembly as claimed in claim 1, wherein the leads are wire bonds.

3. The microelectronic assembly as claimed in claim 1, wherein the heat spreader is partly or entirely made of graphite.

4. The microelectronic assembly as claimed in claim 1, wherein the heat spreader includes a metallic sheet.

5. The microelectronic assembly as claimed in claim 1, wherein the heat spreader covers at least the rear surface of the first microelectronic element.

6. The microelectronic assembly as claimed in claim 1, wherein the heat spreader covers at least the rear surface of the second microelectronic assembly.

7. The microelectronic assembly as claimed in claim 1, wherein the heat spreader covers the rear surfaces of the first and second microelectronic elements.

8. The microelectronic assembly as claimed in claim 7, wherein the heat spreader includes a first portion positioned over the first microelectronic element, a second portion positioned over the second microelectronic element, and a step between the first and second portions.

9. The microelectronic assembly as claimed in claim 1, further comprising thermally conductive balls thermally coupled to the dielectric element.

10. The microelectronic assembly as claimed in claim 9, wherein the thermally conductive balls are attached to second surface of the dielectric element.

11. The microelectronic assembly as claimed in claim 9, wherein each thermally conductive ball includes a metal core embedded therein.

12. The microelectronic assembly as claimed in claim 9, further comprising a thermally conductive connector extending through the dielectric element and coupling one of the thermally conductive balls to the dielectric element.

13. The microelectronic assembly as claimed in claim 1, wherein the entire heat spreader extends along a plane.

14. The microelectronic assembly as claimed in claim 13, further comprising a support element between the heat spreader and the first microelectronic element.

15. A microelectronic assembly, comprising:
first and second units, each unit including:

(1) a dielectric element having oppositely-facing first and second surfaces, at least one aperture extending between the surfaces, the dielectric element having electrically conductive elements thereon;

(2) a first microelectronic element having a rear surface, a front surface facing the first surface of dielectric element, an edge and contacts on the front surface;

(3) second microelectronic element having a rear surface, a front surface facing the first microelectronic element and contacts on the front surface projecting beyond the edge of the first microelectronic element; and

(4) signal leads extending from the contacts of the first and second microelectronic elements through the at least one aperture to at least some of the conductive elements on the dielectric element,

the second unit overlying the microelectronic elements of the first unit, the assembly further comprising stack interconnects electrically connecting at least some of the conductive elements on the dielectric element of the first unit with at least some of the conductive elements on the dielectric element of the second unit; and

at least one heat spreader disposed between the first and second units.

16. The microelectronic assembly as claimed in claim 15, wherein the heat spreader is a monolithic structure

having apertures substantially aligned with the contacts of the first and second microelectronic elements of the first unit.

17. The microelectronic assembly as claimed in claim 15, wherein the heat spreader includes heat spreader portions spaced apart from one another.

18. The microelectronic assembly as claimed in claim 15, wherein the heat spreader is attached to the second surface of the dielectric element of the first unit.

19. The microelectronic assembly as claimed in claim 15, wherein the leads are wire bonds.

20. The microelectronic assembly as claimed in claim 15, wherein the heat spreader includes substantially planar surfaces facing toward respective rear surfaces of the first and second microelectronic elements of the first unit.

21. A system comprising an assembly according to claim 1 and one or more other electronic components electrically connected to the assembly.

22. A system as claimed in claim 21 further comprising a housing, the assembly and the other electronic components being mounted to the housing.

23. A system comprising an assembly according to claim 15 and one or more other electronic components electrically connected to the assembly.

24. A system as claimed in claim 23 further comprising a housing, the assembly and the other electronic components being mounted to the housing.

FIG. 1

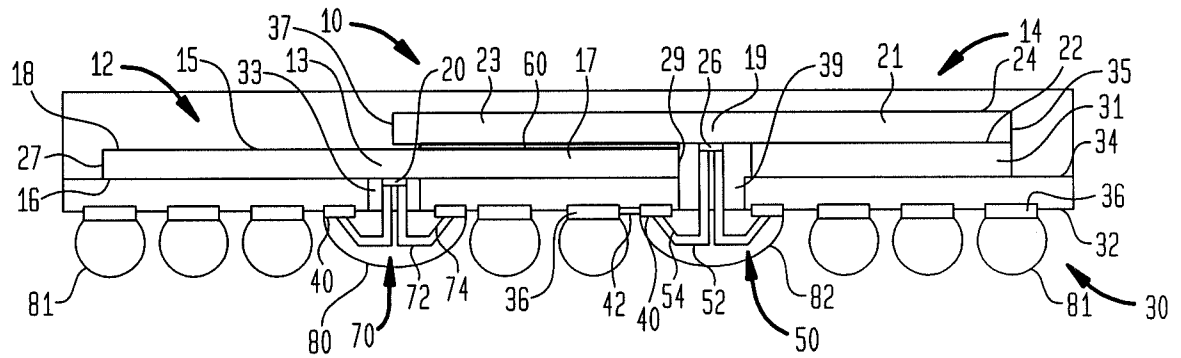


FIG. 2

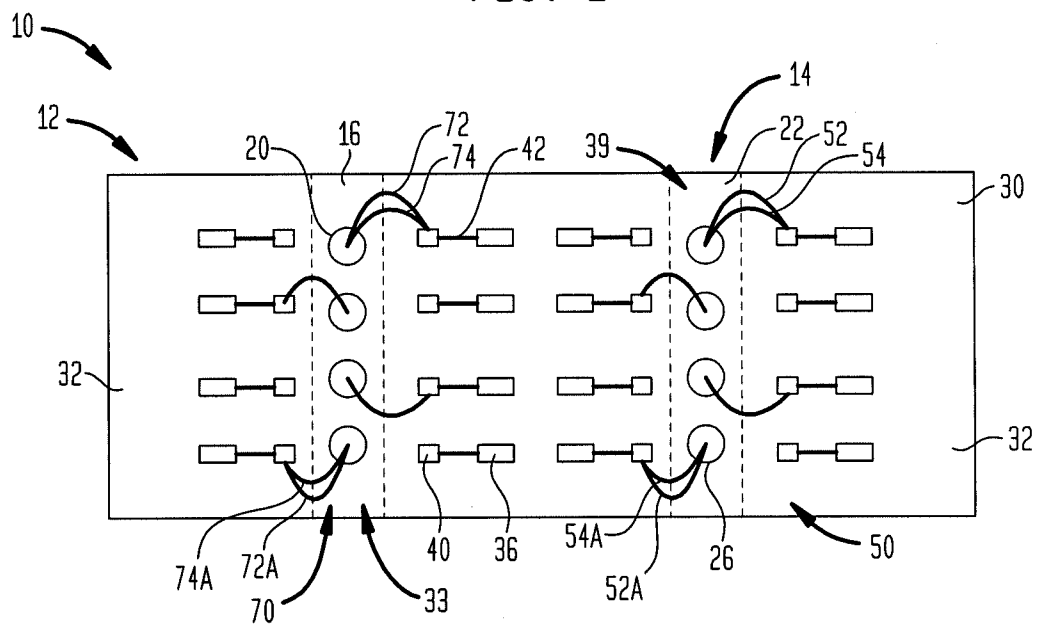


FIG. 3

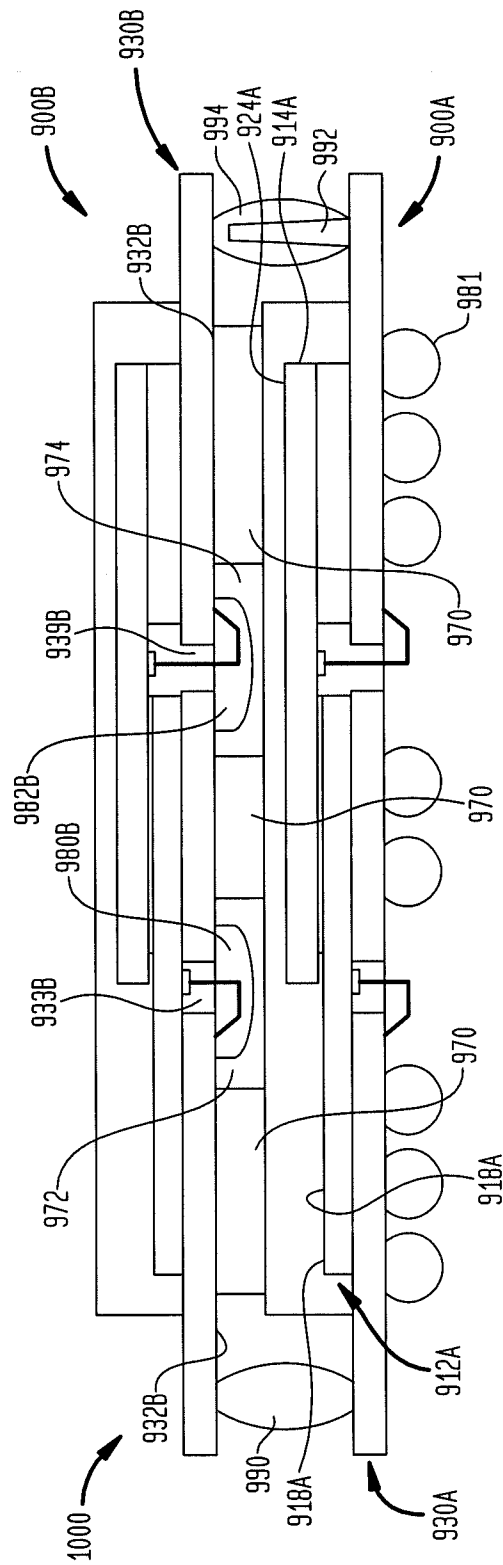


FIG. 4

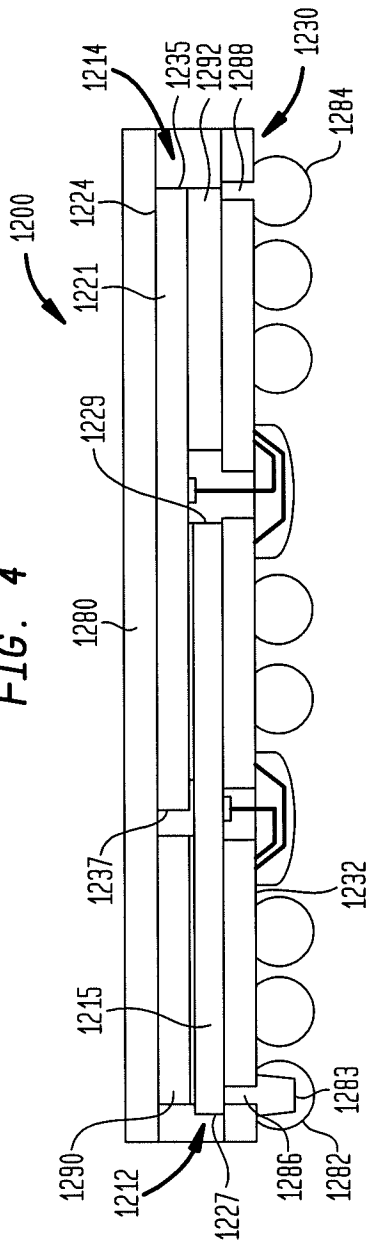


FIG. 5

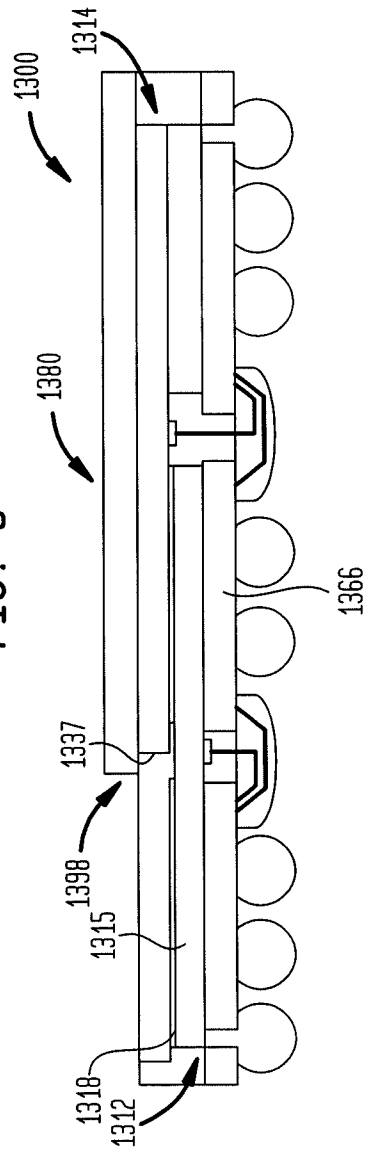


FIG. 6

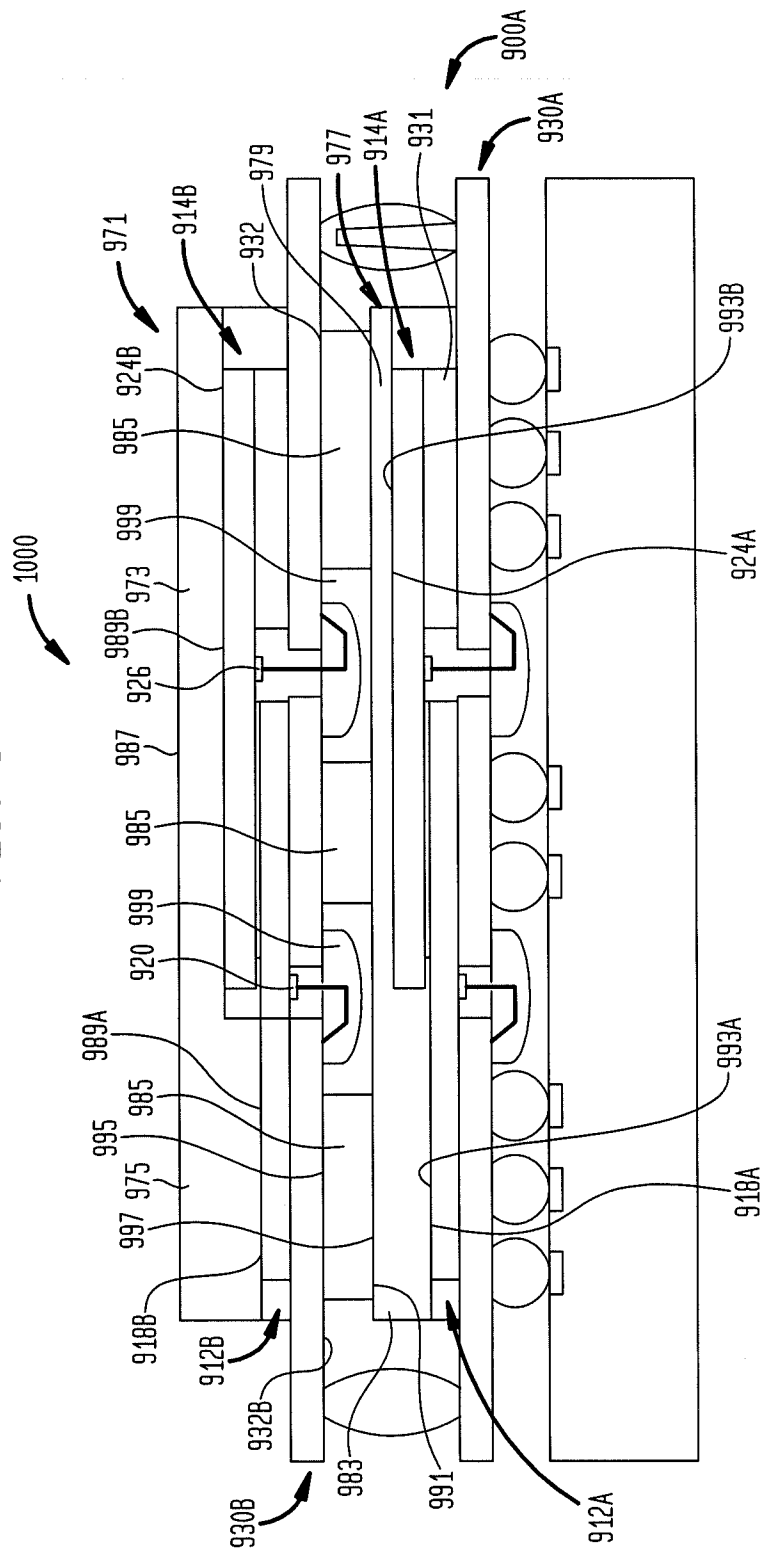
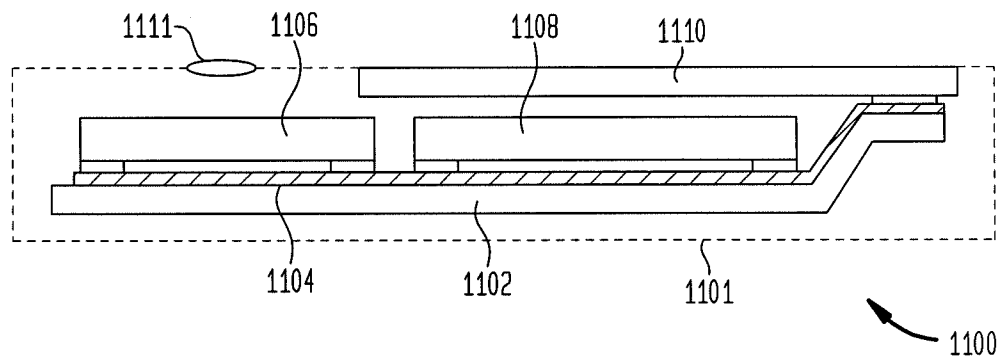


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/056352

A. CLASSIFICATION OF SUBJECT MATTER

INV. H01L25/065 H01L25/10 H01L23/367 H01L23/42 H01L23/498
H01L23/36

ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 703 713 B1 (TSENG WEI-CHENG [TW] ET AL) 9 March 2004 (2004-03-09) column 4, line 9 - line 11; figure 3 column 5, line 56 - line 67 -----	1,2,5,6, 9,10,13, 21,22
X	US 2009/243064 A1 (CAMACHO ZIGMUND R [SG] ET AL) 1 October 2009 (2009-10-01) paragraphs [0032], [0048]; figures 9,15 -----	1-6,9, 10,13, 14,21,22
X	US 2009/045524 A1 (MOHAMMED IYYAS [US] ET AL) 19 February 2009 (2009-02-19) paragraphs [0077], [0079], [0080], [0082], [0098], [0100]; figures 4,6,6b ----- -/-	15-17, 19,20, 23,24

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

26 March 2012

Date of mailing of the international search report

05/04/2012

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2011/056352

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	<p>US 2006/231938 A1 (MANGRUM MARC A [US]) 19 October 2006 (2006-10-19) paragraph [0026]; claim 10; figure 1 -----</p>	15-17,20

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2011/056352

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☒ Claims Nos.: 18
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
1-6, 9, 10, 13-17, 19-24
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box II.2

Claims Nos.: 18

1 Dependent claim 18 is drafted in such a way that the claim as a whole is not in compliance with the provisions of clarity and conciseness of Article 6 PCT. The non-compliance with the substantive provisions is to such an extent, that the search was performed taking into consideration the non-compliance in determining the extent of the search (PCT Guidelines 9.19). In so far as the subject matter of claim 18 can be understood, the features of the 'heat spreader' being attached to the 'second surface of the dielectric element of the first unit' is not sufficiently disclosed in the description such that the person skilled in the art can make this heat spreader (Art. 5 PCT). The 'heat spreader' is disposed between the first and second unit in independent claim 15 and then subsequently, in dependent claim 18 this 'heat spreader' is meant to be attached to the 2nd surface of the dielectric element of the first unit where there is no indication given within the description how this heat spreader is meant to be attached to the second surface. This makes dependent claim 18 very unclear and this is not supported by the description (Art. 6 PCT). For the purposes of this communication, claim 18 could not be searched, for the above-mentioned reasons.

The applicant's attention is drawn to the fact that claims relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure. If the application proceeds into the regional phase before the EPO, the applicant is reminded that a search may be carried out during examination before the EPO (see EPO Guideline C-VI, 8.2), should the problems which led to the Article 17(2) declaration be overcome.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-6, 9, 10, 13, 14, 21, 22

Directed to an individual first unit of a microelectronic assembly (according to claim 1) where the heat spreader is partly or entirely made of graphite or includes a metallic sheet or a support element exists between the heat spreader and the first microelectronic element.

2. claims: 7, 8

Directed to an individual first unit of a microelectronic assembly (according to claim 1) where the heat spreader covers the rear surfaces of the first and second microelectronic elements.

3. claims: 11, 12

Directed to an individual first unit of a microelectronic assembly (according to claims 1 and 9), where each thermally conductive ball includes a metal core embedded therein or a thermally conductive connector extends through the dielectric element and couples to one of the thermally conductive balls to the dielectric element.

4. claims: 15-20, 23, 24

Directed to first and second units of microelectronic assemblies with the following features making a contribution over that of the prior art D1 (US60703713): the second unit overlying the microelectronic elements of the first unit, the assembly further comprising stack interconnects electrically connecting at least some of the conductive elements on the dielectric element of the first unit with at least some of the conductive elements on the dielectric element of the second unit; and the heat spreader is disposed between the first and second units.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2011/056352

Patent document cited in search report	Publication date	Patent family member(s)	Publication date	
US 6703713	B1	09-03-2004	TW 557556 B US 6703713 B1	11-10-2003 09-03-2004

US 2009243064	A1	01-10-2009	NONE	

US 2009045524	A1	19-02-2009	NONE	

US 2006231938	A1	19-10-2006	EP 1875503 A2 JP 4768012 B2 JP 2008537333 A KR 20080013864 A US 2006231938 A1 WO 2006112949 A2	09-01-2008 07-09-2011 11-09-2008 13-02-2008 19-10-2006 26-10-2006
