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(54) HEAT-RECOVERABLE CAP

(71) We, RAYCHEM CORPORATION a corporation organised according to the laws of the State of California, United States of America, of 300 Constitution Drive, Menlo Park, California 94025, United States of America, do hereby declare the invention, which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the sealing of electrical components.

It is frequently important, and sometimes critical, that electrical components should be sealed from the atmosphere to prevent their contamination and deterioration. The sealing of electrical components is especially important in the field of semiconductor packaging where the microcircuitry of a semiconductor chip is extremely susceptible to failure. The size of the circuitry on such miniature components is often of the order of microns and they are readily subject to short or open failure upon exposure to the environment. In addition to failure of the connective circuitry, atmospheric contamination of the semiconductor material itself may drastically affect its electrical response.

Such components are frequently sealed and protected from the atmosphere by fusing a glass layer over them. Alternatively, a metal cap may be used, for example, by soldering the cap over the substrate upon which the semiconductor chip has been mounted.

These methods of sealing electrical components to protect them from the environment requires subjecting the electrical device to considerable thermal stress, because the solder or glass must be heated to its melting temperature. For many electrical applications where expensive, high density semiconductor chips are utilised, a hermetic seal is required. Such seals must allow no detectable leakage when tested with a helium mass spectrometer leak tester of sensitivity 1×10^{-8} scc/sec. in accordance with MIL-Standard 883. Previous methods of forming them have in general involved delicate and expensive sealing operations, for example precious metal soldering or the fusion of a sealing glass to itself and to metallic leads. Furthermore, once a component is protected from the atmosphere by such methods, it cannot be easily replaced. On the other hand, if changes in circuitry are required, the fabrication of an entirely new package is often required.

The present invention provides a method of sealing an electrical component, which comprises the steps of

(a) positioning the component on a substrate having means for electrically connecting the component and having a wall or walls to surround said component, said wall or walls defining an aperture which is to be sealed,

(b) forming a heat-recoverable (as hereinbefore defined) sealing member by mechanically deforming it from an original heat-stable form having transverse dimensions greater than those of said aperture to a second heat-unstable form having transverse dimensions less than those of said aperture,

(c) positioning said heat-recoverable sealing member within said aperture and over said component, and

(d) warming said sealing member or allowing said sealing member to warm, so that it recovers towards its original heat-stable form and thereby seals the aperture.

It will be appreciated that more than one electrical component may be sealed against the atmosphere or any other environment by a single heat-recoverable sealing member.

Upon recovery the sealing member may contact the wall(s) of the substrate directly

and exert a sealing pressure upon them. For this purpose the wall(s) may be shaped to enhance the sealing effect, for example they may be formed with a lip or shoulder upon which the edges of the sealing member will sit after recovery. Preferably, however, the wall(s) comprise a sealing ring in which the heat-recoverable sealing member is positioned prior to recovery. Such a ring may, for example, be made from a metal or a hard plastics material and may be bonded to the substrate, for example a ceramic substrate, by known techniques such as soldering or brazing. The sealing ring is preferably contoured to enhance the seal formed upon recovery and may, for example, be formed with an inward bend so as to form a V-shape into which the edges of the sealing member will wedge upon recovery.

The sealing member is preferably one which has been deformed from a flat disc shape to a dish shape and which, upon recovery, will return towards its original flat shape. When such a dish shaped sealing member is employed the forces exerted upon the wall upon recovery may easily be calculated. The forces should be such so as to deform the inner surface of the wall(s) or the sealing ring sufficiently to seal the component, but not so great as to crack the wall(s) or the sealing ring. The force at the edge may be calculated, for example, by using stress-strain formulas such as those given in "Formulas for Stress-Strain", Roark, 4th Edition, McGraw Hill, 1965, page 303. By adjusting the height and thickness of the dish the forces at the interface may be controlled so as to give an effective seal without any danger of cracking.

The transverse dimensions of the deformed disc should be slightly less than the transverse dimensions of the wall(s) or the sealing ring. Thus, for a wall dimension of .500 inches the transverse dimension of the disc is preferably .495 inches. With such dimensions the disc can easily be placed inside the substrate walls whilst in its unrecovered state, but cannot return completely to its original flat form of transverse dimension greater than .500 inches, thus ensuring that a pressure is exerted at the interface.

Although the use of a disc shaped sealing member is preferred because it is easy to calculate the recovery forces generated at the interface, it will be appreciated that the particular size and shape of the sealing member will often be dictated by the required configuration of the final article, e.g. the electronic package. The edge forces of various other shapes, including squares and rectangles may be calculated approximately from stress-strain formulae.

Additionally, the configuration of the sealing member may be designed so as to increase the sealing force, to aid correct positioning of the sealing member prior to recovery or, in some cases, to facilitate removal of the sealing member at a later stage. For example, a generally disc shaped sealing member may be provided with a control protrusion which facilitates handling of the member using a suitable tool.

The most important advantages of the present invention are derived from the sealing member being heat-recoverable. By a "heat-recoverable article" there is herein meant one which has been mechanically deformed from an original heat-stable configuration to a second heat-unstable configuration and which is capable of returning, or recovering, towards said original configuration upon the application of heat alone. It will be appreciated that the dimensional changes caused by heat-recovery are independent of those occasioned by normal thermal expansion and contraction of the material from which the heat-recoverable article is made.

Such heat-recoverable articles have typically been made from polymeric materials, especially cross-linked polymers, and have been described, for example, in U.S. Patents Nos. 2,027,962 (Currie), 3,086,242 (Cook *et al*) and 3,415,287.

However, quite recently, it has been discovered that such articles can also be made from certain metals, sometimes called "memory metals" or "memory alloys". These metals exhibit changes in strength and configurational characteristics on passing through a transformation temperature, usually called the martensitic transformation temperature, and can be used to make heat-recoverable articles by deforming an article made from them whilst the metal is in its low temperature, e.g. martensitic, state. The article will retain its deformed configuration until it is warmed above the transition temperature, e.g. to an austenitic state, when it will recover towards its original configuration. The deformation used to place the material in the heat-unstable configuration is commonly referred to as thermally recoverable plastic deformation and can also, in certain cases, be imparted by introducing strains into the article above the transition temperature, whereupon the article assumes the deformed configuration on cooling through the transition temperature. It should be understood that the transition temperature may be a temperature range and that, as hysteresis usually occures, the precise temperature at which transition occurs may be pend on whether the temperature is rising or falling. Furthermore, the transition temperature is a function of other parameters, including the stress applied to the material,

the temperature rising with increasing stress.

Amongst such memory metals there may especially be mentioned various alloys of titanium and nickel which are described, for example, in U.S. Patents Nos. 3,174,851, 3,351,463, 3,753,700, 3,759,552, British Patents Nos. 1,327,441 and 1,327,442 and NASA Publication SP 5110, "55-Nitinol-The Alloy with a Memory, etc." (U.S. Government Printing Office, Washington, D.C. 1972), the disclosures of which are incorporated herein by reference. The property of heat-recoverability has not, however, been solely confined to such titanium-nickel alloys. Thus, for example, various beta-brass alloys have been demonstrated to exhibit this property in, e.g. N. Nakanski et al, *Scripta Metallurgic 5*, 433-440 (Pergamon Press 1971) and such materials may be doped to lower their transition temperatures to cryogenic regimes by known techniques. Similarly, 304 stainless steels have been shown to enjoy such characteristics, E. Enami *et al, id* at pp. 663-68. These disclosures are similarly incorporated herein by reference. For convenience, the low-temperature state will from now on be referred to as the martensitic state and the high-temperature state as the austenite state, this terminology being commonly accepted in the art in respect of memory metals in general.

Both types of heat-recoverable material can be used to form the sealing member used in the process of the present invention.

For example, a metal sealing member can be deformed whilst in the martensitic state to such a dimension that it fits snugly within the aperture defined by the wall(s) of a substrate onto which the electrical component has been placed. Upon inserting the deformed sealing member into the aperture and warming it to the austenitic state the sealing member attempts to recover to its original configuration exerting a substantial force against the wall(s), the force being sufficient to seal the electrical component. Likewise, in the case of plastics sealing members, by heating and deforming a heat-recoverable polymeric material to the appropriate dimension and then quenching it at that dimension, upon heating, the plastics will attempt to recover to its original configuration. By accurately dimensioning the sealing member as well as the substrate, sealing pressure may be accurately and reproducibly controlled so as to seal the electrical component.

In the case of metals, transition to the austenitic stable state generally occurs at or below room temperature so the electrical components are not subjected to heat which may cause thermal degradation. In the case of heat-recoverable plastics, heat recovery will generally take place at or below 300°F, well below temperatures which will cause thermal degradation of solder connections or oxidation of conductors.

Amongst suitable metals there may be mentioned those having transition temperatures within the range of from +135°C to −196°C, especially nickel-titanium alloys, for example, an alloy containing 47.1 atom percent nickel, 49.4 atom percent titanium and 3.5 atom percent iron, which alloy has a transition temperature of approximately −125°C. Such an alloy can readily be brought into its martensitic state by immersing it in liquid nitrogen.

Amongst suitable polymeric materials there may especially be mentioned polyarylene plastics. These are polymers consisting predominantly of aryl, e.g. phenyl or substituted phenyl, groups which may be linked, for example, by direct linkages or by alkylene, carbonayl, sulphonyl or ether linkages, or mixtures of the above linkages. Preferred polyarylenes are described in Belgian Patents Nos. 779,457; 779,458 and 779,459. These materials may have a highly crystalline nature and, even without cross-linking, can be deformed at room temperature and yet still have sufficient elastic memory to return to their original configuration upon heating, thereby exerting a force sufficient to effect a seal.

To ensure that the sealing member will give a completely effective seal it will preferably be made from a hard, non-deformable material when the substrate wall or the sealing ring is soft and deformable. On the other hand, the sealing member may be made from a softer, deformable material when the substrate wall or the sealing ring is itself hard and non-deformable. In all cases the materials should be selected and the dimensions of the sealing member chosen to ensure that a sufficient pressure is exerted upon the substrate wall to cause the softer material at the interface to deform and thus seal the electrical component. Thus, for example, when a metal or hard, non-deformable plastics sealing member is employed the substrate wall(s) or the sealing ring will preferably be formed from a soft metal, e.g. gold, nickel or tin, or a plastics material whch will yield upon recovery of the sealing member so as to form a gas-tight seal at the interface.

It will be seen that by the present invention there is provided a method of sealing electrical components which is more reliable and less costly than the methods previously employed. Another important advantage is that the electrical component or substrate is not subjected to excessively high temperatures, thereby permitting the use of a wider range of component materials and substrates, including plastics.

Another important advantage is that the

sealing member can be readily removed to expose the electrical component if repair or replacement is necessary. In the previously employed methods using, for example, glass or solder caps it was impossible to remove the sealing member without subjecting the package to high temperatures. In the present invention, however, a metal sealing member can readily be removed by immersing the package in liquid nitrogen so as to cool the metal to its martensitic state. In this state the sealing member may be deformed and removed. Alternatively the metal sealing member could be removed by crushing it whilst in the austenitic state. Plastic sealing members can be removed by heating them to a temperature at which they can be deformed and removed from the package. In all cases removal is facilitated by the provision of a protrusion on the sealing member, as described above.

It will be appreciated that one of the most important applications of the present invention is in the field of electronics, especially in the manufacture of electronic packages. Accordingly, the substrate is preferably one which is suitable for the mounting of electronic components, being made, for example, from an inorganic insulative material such as a ceramic or a glass or an organic insulative material such as a polymeric material. Necessary means for electrical connection may be metallized on said substrate by conventional methods or may be discrete wires provided on or within said substrate.

Various forms of the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which

Figure 1 is a top view of an electronic package suitable for use in the present invention;

Figure 2 is a section through said package after an electrical component has been sealed therein in accordance with the present invention;

Figure 3 is an enlarged view taken from Figure 2 showing more clearly the interface between the sealing member and the substrate wall;

Figures 4 to 6 represent different sealing members for use in the present invention, before and after deformation;

Figure 7 is a section showing a substrate provided with a sealing ring in accordance with the present invention; and

Figure 8 is a sectional view illustrating a method of deforming and inserting the sealing member in one operation.

Referring now to Figures 1 and 2 the electronic package 1 comprises suitable substrate 2 metallized with electrical conductors 4 to provide input/output means for an electrical component 6 shown in Figure 2. Substrate 2 may be made of any insulative material, including inorganic insulators (e.g. ceramics and glass) or organic insulators (e.g. epoxy resins, phenolic resins, melamine resins, nylon, polyesters, Teflon (Trade Mark), polyimides and polyarylenes). When organic insulators are used as the substrate material, reinforcing agents such as glass fibre or microspheres are desirable to impart the required rigidity to the electronic package 1.

A metallized die attach pad 8 is utilized for receiving the component 6 to be attached and electrically connected. The die attach pad 8 is generally metallized with a noble metal such as gold. Similarly conductors 4 may have a top layer of gold, beneath which may be less expensive metals such as copper. Preferably, the metal conductors 4 are deposited onto the substrate 2 by means of known techniques such as sputtering, vapour deposition or electroplating. However, discrete wiring may also be used in the electronic packages used in the present invention. The electrical conductors 4 are then connected to a second level packaging (not shown) via conductors 10. The substrate 2 may be of the multi-layer variety so that the conductors 10 are sandwiched there between. Such substrates permit denser packaging since multilayer circuitry may be utilized. Of course, a single layer substrate 2 may also be utilized where high circuit density is not required. As best seen in Figure 2, a wall 12 is provided for encompassing the die attach pad 8 upon which the electrical component 6 is to be attached.

After positioning of the electronic component 6 over die attach pad 8, a heat recoverable sealing member 14 is placed into the walls 12 and over the component 6 so as to seal the component from the atmosphere.

Referring to Figure 3, wall 12 is provided with a lip 18 to receive the heat recoverable sealing member 14. The lip surface at which a seal between the heat-recoverable sealing member 14 and the wall 12 is formed should be made from a material which will deform upon the exertion of force by the heat-recoverable material. In the case of a titanium-nickel metal sealing member, the lip surface should be made from a material softer than the titanium-nickel alloy, e.g. gold, nickel or a plastics material.

Sealing member 14 may, for example, be prepared from a planar disc of a nickel titanium alloy containing 47.1% nickel, 49.4% titanium and 3.5% iron. This composition results in a material with a transition temperature of approximately −125°C. The disc is reduced to a temperature be-

low its transition temperature by immersing it in liquid nitrogen which exhibits a stable temperature of −196°C. While held at this reduced temperature, the disc is subjcted to sufficient force, e.g. in a press, to cause thermally recoverable plastic deformation to take place whereby the disc is placed in a heat-unstable dished configuration. The deformed disc is held at a temperature below its transition temperature, e.g. by continued immersion in liquid nitrogen, until it is ready for use.

The disc 14 is inserted into the walled substrate 2 while in the cooled state, after which it is allowed to warm. This method results in little if any thermal stress. Obviously, the electrical component is not subjected to high temperatures as was the case with the prior art methods. In most instances, the entire electronic package 1 can be cooled to liquid nitrogen temperature during the sealing operation, although this is not essential.

Alternatively, member 14 may be made of a polymer material capable of being made heat-recoverable so as to exert a force when caused to recover, e.g. a polyarylene.

The configuration of sealing member 14 should be such as to fit easly into walls 12 while in the deformed state. The use of round walls with a heat-recoverable member which has been deformed from a flat shape to a dish is particularly suited for this application since the sealing pressures of the wall may be readily calculated. Protrusion 16 is provided on the heat-recoverable sealing member 14, so as to allow a holding tool to insert and properly position the member within the walls 12 of the electronic package 1.

The surface configuration of the sealing members 14 may be designed and formed so as to increase the sealing force or aid in insertion of the member into the substrate walls. Figure 4a is a cross-sectional view of a flat disc prior to deformation with Figure 4b depicting the disc after deformation. Upon warming the deformed disc to its stable state, the disc will tend to return to the original shape, thereby exerting a force against the substrate walls.

Figures 5a and 5b depict a disc cross section before and after deformation having a large control protrusion which assists the insertion of the disc into the walls of the substrate.

Figures 6a and 6b depict a flat disc which is deformed into a "doughnut" shape. This configuration results in a substantially horizontal force being exerted by the member against the substrate wall on warming.

As explained above, the wall may be an integral part of the substrate, and have the same composition as the substrate. However, because of the hardness of inorganic substrates such as ceramics or glass, it is preferable to provide a wall having an inner surface of considerably softer material. Thus, a seperate metallic ring may be attached to the ceramic substrate, the ring having that portion of its inner surface which is contacted by the heat-recoverable sealing member 14 coated with a soft metal such as gold or nickel. Of course, where the wall 12 and the substrate 2 form an integral component, such as a ceramic, the inner wall may still be coated with a softer material such as gold, nickel or tin. When the substrate and wall are formed from softer, organic insulators, coating of the interior surface of the wall with a soft material may not be necessary.

However, even if the interior surface of the wall is a suitable soft material, it may still be desirable to provide a sealing ring into which the sealing member can be tightly wedged.

For example, Figure 7 illustrates the use of a sealing ring so that the sealing member does not directly contact the substrate walls. The ring 18 is preferably made of a rigid material such as Kovar (Trade Mark) (an alloy of copper, nickel and iron having a coefficient of expansion similar to that of glass). Preferably, the ring is configured with an inward bend so as to form a V-shape into which the sealing member, upon recovery, will wedge. Unlike the straight side wall configuration shown in Figure 3, the V configuration ensures retension of the disc 14 and a "double seal" on two surfaces of the ring 18. The ring 18 may be bonded to substrate 20 on metallized pads 22 by known techniques such as soldering or brazing. The ring 18 is placed over the substrate cavity 24 into which the electrical component is inserted. Input/output leads 26 are provided for connection with an electrical component.

Figure 8 illustrates a method of deforming the sealing member and positioning it over the electrical component in one operation. An electrical component, similar to that shown in Figure 2, is sealed via a heat-recoverable sealing member 30 which is deformed by punch 32 into a concave configuration. The top walls of the substrate 2 define an opening the dimensions of which are slightly less than those of the undeformed sealing member, so that upon insertion and operation of the punch 3 the member 30 is deformed to the concave configuration shown. The walls 36 are curved to form a lip 34 upon which the concave sealing member 30 sits flush. The lip 34 also serves as a stop to prevent the sealing member 30 from pressing and damaging the electrical component 6.

In the case of a metal sealing member 30, the member is inserted and deformed in its unstable martensitic state, and after insertion is allowed to return to its stable austenitic state. The member 30 will attempt to return to its original flat configuration, exerting pressure against the walls and sealing the electrical component 6.

In the case of a plastics sealing member 30, a heat-recoverable material is deformed during insertion, after which it is heated to cause it to exert pressure and seal the electrical component 6.

WHAT WE CLAIM IS:

1. A method of sealing an electrical component, which comprises the steps of
   (a) positioning the component on a substrate having means for electrically connecting the component and having a wall or walls to surround said component, said wall or walls defining an aperture which is to be sealed,
   (b) forming a heat-recoverable (as hereinbefore defined) sealing member by mechanically deforming it from an original heat-stable form having transverse dimensions greater than those of said aperture to a second heat-unstable form having transverse dimensions less than those of said aperture,
   (c) positioning said heat-recoverable sealing member within said aperture and over said component, and
   (d) warming said sealing member or allowing said sealing member to warm, so that it recovers towards its original heat-stable form and thereby seals the aperture.

2. A method as claimed in claim 1, wherein the wall(s) of the substrate is(are) formed with a lip or shoulder upon which the edges of the sealing member can sit after recovery.

3. A method as claimed in claim 1 or claim 2, wherein the wall(s) comprise(s) a sealing ring into which the sealing member is positioned prior to recovery.

4. A method as claimed in claim 3, wherein the sealing ring is made from a metal or a plastics material.

5. A method as claimed in claim 3 or claim 4, wherein the sealing ring is contoured to enhance the seal formed upon recovery of the sealing member.

6. A method as claimed in claim 5, wherein the sealing ring is bent inwardly to form a V into which the edges of the sealing member will wedge upon recovery.

7. A method as claimed in any one of claims 1 to 6, wherein the substrate wall(s) or the sealing ring is(are) formed from, or coated with, a metal or a plastics material which will yield on recovery of the sealing member.

8. A method as claimed in claim 7, wherein the metal is gold, tin or nickel.

9. A method as claimed in claim 7, wherein the plastics material is a polyarylene.

10. A method as claimed in any one of claims 1 to 9, wherein the heat-recoverable sealing member is one which has been deformed from a flat disc shape to a dish shape and which, upon recovery, will return towards its original flat shape.

11. A method as claimed in any one of claims 1 to 10, wherein the sealing member is provided with a protrusion to facilitate handling of the member during positioning and removal.

12. A method as claimed in any one of claims 1 to 11, wherein the heat-recoverable sealing member is made from a memory metal.

13. A method as claimed in claim 12, wherein the memory metal has a transition temperature in the range of from +135°C to −196°C.

14. A method as claimed in claim 12 or claim 13, wherein the memory metal is an alloy of nickel and titanium.

15. A method as claimed in any one of claims 1 to 11, wherein the heat-recoverable sealing member is made from a plastics material.

16. A method as claimed in claim 15, wherein the plastics material is a polyarylene.

17. A method as claimed in any one of claims 1 to 16, wherein the substrate is part of an electronic package.

18. A method as claimed in claim 17, wherein the substrate is made from a ceramic or a glass.

19. A method as claimed in claim 17, wherein the substrate is made from an organic insulating material.

20. A method as claimed in any one of claims 1 to 19, wherein the electrical component is a semi-conductor chip.

21. A method as claimed in any one of claims 1 to 20, wherein the sealing member is deformed to make it heat-recoverable at the same time as it is positioned within the wall(s) of the substrate.

22. A method as claimed in claim 21, wherein the wall(s) of the substrate is(are) provided with means to assist deformation of the sealing member.

23. A method as claimed in claim 1, carried out substantially as described herein with reference to, and as illustrated in, the accompanying drawings.

24. A packagel containing an electrical component positioned on a substrate having means for electrically connecting the component, said substrate also having a wall(s) surrounding said component which is sealed against the atmosphere by the provision of a sealing member which covers

In the case of a metal sealing member 30, the member is inserted and deformed in its unstable martensitic state, and after insertion is allowed to return to its stable austenitic state. The member 30 will attempt to return to its original flat configuration, exerting pressure against the walls and sealing the electrical component 6.

In the case of a plastics sealing member 30, a heat-recoverable material is deformed during insertion, after which it is heated to cause it to exert pressure and seal the electrical component 6.

WHAT WE CLAIM IS:

1. A method of sealing an electrical component, which comprises the steps of
   (a) positioning the component on a substrate having means for electrically connecting the component and having a wall or walls to surround said component, said wall or walls defining an aperture which is to be sealed,
   (b) forming a heat-recoverable (as hereinbefore defined) sealing member by mechanically deforming it from an original heat-stable form having transverse dimensions greater than those of said aperture to a second heat-unstable form having transverse dimensions less than those of said aperture,
   (c) positioning said heat-recoverable sealing member within said aperture and over said component, and
   (d) warming said sealing member or allowing said sealing member to warm, so that it recovers towards its original heat-stable form and thereby seals the aperture.

2. A method as claimed in claim 1, wherein the wall(s) of the substrate is(are) formed with a lip or shoulder upon which the edges of the sealing member can sit after recovery.

3. A method as claimed in claim 1 or claim 2, wherein the wall(s) comprise(s) a sealing ring into which the sealing member is positioned prior to recovery.

4. A method as claimed in claim 3, wherein the sealing ring is made from a metal or a plastics material.

5. A method as claimed in claim 3 or claim 4, wherein the sealing ring is contoured to enhance the seal formed upon recovery of the sealing member.

6. A method as claimed in claim 5, wherein the sealing ring is bent inwardly to form a V into which the edges of the sealing member will wedge upon recovery.

7. A method as claimed in any one of claims 1 to 6, wherein the substrate wall(s) or the sealing ring is(are) formed from, or coated with, a metal or a plastics material which will yield on recovery of the sealing member.

8. A method as claimed in claim 7, wherein the metal is gold, tin or nickel.

9. A method as claimed in claim 7, wherein the plastics material is a polyarylene.

10. A method as claimed in any one of claims 1 to 9, wherein the heat-recoverable sealing member is one which has been deformed from a flat disc shape to a dish shape and which, upon recovery, will return towards its original flat shape.

11. A method as claimed in any one of claims 1 to 10, wherein the sealing member is provided with a protrusion to facilitate handling of the member during positioning and removal.

12. A method as claimed in any one of claims 1 to 11, wherein the heat-recoverable sealing member is made from a memory metal.

13. A method as claimed in claim 12, wherein the memory metal has a transition temperature in the range of from +135°C to −196°C.

14. A method as claimed in claim 12 or claim 13, wherein the memory metal is an alloy of nickel and titanium.

15. A method as claimed in any one of claims 1 to 11, wherein the heat-recoverable sealing member is made from a plastics material.

16. A method as claimed in claim 15, wherein the plastics material is a polyarylene.

17. A method as claimed in any one of claims 1 to 16, wherein the substrate is part of an electronic package.

18. A method as claimed in claim 17, wherein the substrate is made from a ceramic or a glass.

19. A method as claimed in claim 17, wherein the substrate is made from an organic insulating material.

20. A method as claimed in any one of claims 1 to 19, wherein the electrical component is a semi-conductor chip.

21. A method as claimed in any one of claims 1 to 20, wherein the sealing member is deformed to make it heat-recoverable at the same time as it is positioned within the wall(s) of the substrate.

22. A method as claimed in claim 21, wherein the wall(s) of the substrate is(are) provided with means to assist deformation of the sealing member.

23. A method as claimed in claim 1, carried out substantially as described herein with reference to, and as illustrated in, the accompanying drawings.

24. A packagel containing an electrical component positioned on a substrate having means for electrically connecting the component, said substrate also having a wall(s) surrounding said component which is sealed against the atmosphere by the provision of a sealing member which covers

said component and which has been inserted within the wall(s) and heat-recovered (as hereinbefore defined) so that its transverse dimensions increased to exert a sealing pressure against said wall(s).

25. A package as claimed in claim 24, wherein the wall(s) of the substrate is(are) formed with a lip or shoulder upon which the sealing member sits.

26. A package as claimed in claim 24 or claim 25 (wherein the wall(s) comprise(s) a sealing ring within which the sealing member is positioned.

27. A package as claimed in claim 26, wherein the sealing ring is made from a metal or a plastics material.

28. A package as claimed in claim 26 or claim 27, wherein the sealing ring is bent inwardly to form a V into which the edges of the sealing member are wedged.

29. A package as claimed in any one of claims 24 to 28, wherein the substrate wall(s) or the sealing ring is(are) formed from, or coated with, a metal or a plastics material.

30. A package as claimed in claim 29, wherein the metal is tin, gold or nickel.

31. A package as claimed in claim 29, wherein the plastics material is a polyarylene.

32. A package as claimed in any one of claims 24 to 31, wherein the sealing member comprises a dish shaped member which has recovered towards a flat disc shape.

33. A package as claimed in any one of claims 24 to 32, wherein the sealing member is provided with a protrusion to facilitate removal thereof.

34. A package as claimed in any one of claims 24 to 33, wherein the sealing member is made from a memory metal.

35. A package as claimed in claim 34, wherein the memory metal has a transition temperature in the range of from +135°C to −196°C.

36. A package as claimed in claim 34 or claim 35, wherein the memory metal is an alloy of nickel and titanium.

37. A package as claimed in any one of claims 24 to 33, wherein the sealing member is made from a plastics material.

38. A package as claimed in claim 37, wherein the plastics material is a polyarylene.

39. A package as claimed in any one of claims 24 to 38, wherein the substrate is made from a ceramic or a glass.

40. A package as claimed in any one of claims 24 to 38, wherein the substrate is made from an organic insulating material.

41. A package as claimed in any one of claims 24 to 40, wherein the package is an electronic package.

42. A package as claimed in claim 41, wherein the electrical component is a semi-conductor chip.

43. A package as claimed in claim 24, produced by a method as claimed in any one of claims 1 to 23.

44. A package as claimed in claim 24, substantially as described herein with reference to, and as illustrated in, the accompanying drawings.

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