[0005] Some manufacturers have offered a dielectric frame made of liquid crystal polymer (LCP) which is overmolded onto copper leads to create a frame. LCP has a close CTE match to copper. The frame/lead subassembly can then be bonded onto a copper flange (after chips have been AuSn soldered onto the flange) using epoxy. However, LCP is difficult to bond with epoxy due to its extreme chemical inertness. A common failure mechanism of LCP parts is leakage at the interface between the LCP and a metal (e.g., as observed during gross leak testing in a Fluorinert® bath). Sometimes the flange must be sandblasted in order to achieve adequate adhesion between the flange and the LCP frame. Additionally, steps such as bonding the LCP frame to the flange between die attachment and wire bonding are necessary.

[0006] It would be desirable to develop new air cavity packages that are simpler and/or less expensive to produce. It would also be desirable to create an air cavity package with a copper base / flange that is fully assembled with a plastic frame and electrical leads, and that can withstand subsequent assembly operations (e.g., AuSn die attachment and lid attachment) that reach temperatures of 230°C and can withstand temperature cycling (from minus 50°C to +85°C for one thousand cycles).

BRIEF DESCRIPTION

[0007] The present disclosure relates to air cavity packages including a dielectric frame made of a polyimide or a liquid crystal polymer (LCP). Such air cavity packages can be highly stable during temperature cycling, since all materials share approximately the same coefficient of thermal expansion.

[0007a] According to a first aspect, there is provided an air cavity package adapted to contain a die, comprising: a flange having an upper surface; and a dielectric frame having an upper surface and a lower surface, the lower surface of the dielectric frame being attached to the upper surface of the flange via a thermoplastic polyimide; wherein the dielectric frame is made of a polyimide or a liquid crystal polymer; and a first conductive lead and a second conductive lead, attached to opposite sides of the upper surface of the dielectric frame, wherein the first conductive lead and the second conductive lead are attached to the upper surface of the dielectric frame by a thermoplastic polyimide.

[0007b] According to a second aspect, there is provided a method for forming an air cavity package, comprising: joining a lower surface of a dielectric frame to an upper surface of a flange using a first thermoplastic polyimide; joining a first conductive lead and a second lead to an upper surface of the dielectric frame using a second thermoplastic polyimide; and curing the first thermoplastic polyimide and the second thermoplastic polyimide, either separately or simultaneously; wherein the dielectric frame comprises a polyimide or a liquid crystal polymer.

[0008] Disclosed in various embodiments herein is an air cavity package adapted to contain a die, comprising: a flange having an upper surface; and a dielectric frame having an upper surface and a lower surface, the lower surface being attached to the upper surface of the flange; wherein the dielectric frame is made of a polyimide or a liquid crystal polymer.

[0009] As disclosed in the above aspects, the air cavity package further comprises a first conductive lead and a second conductive lead, attached to opposite sides of the upper surface of the dielectric frame. The first conductive lead and the second conductive lead are attached to the upper surface of the dielectric frame by a thermoplastic polyimide. The first conductive

lead and the second conductive lead can be made of copper, nickel, a copper alloy, a nickel-cobalt ferrous alloy, or an iron-nickel alloy. The copper alloy may be selected from the group consisting of CuW, CuMo, CuMoCu, and CPC.

[0010] The flange can be made of copper, a copper alloy, aluminum, an aluminum alloy, AlSiC, AlSi, Al/diamond, Al/graphite, Cu/diamond, Cu/graphite, Ag/diamond, CuW, CuMo, Cu:Mo:Cu, Cu:CuMo:Cu (CPC), Mo, W, metallized BeO, or metallized AlN.

[0011] In some embodiments, the flange is a substrate plated with one or more metal sublayers. The one or more metal sublayers can be made of nickel (Ni), gold (Au), palladium (Pd), chromium (Cr), or silver (Ag).

[0012] As disclosed in the above aspects, the dielectric frame is attached to the upper surface of the flange via a thermoplastic polyimide.

[0013] In some embodiments, the dielectric frame further comprises a filler. The filler can be selected from the group consisting of ceramic powder, glass powder, and chopped glass fibers.

[0014] The dielectric frame may have a dielectric constant of about 3.0 to about 5.0.

[0015] Also disclosed are methods for forming an air cavity package, comprising: joining a lower surface of a dielectric frame to an upper surface of a flange using a first adhesive composition; joining a first conductive lead and a second lead to an upper surface of the dielectric frame using a second adhesive composition; and curing the first adhesive composition and the second adhesive composition, either separately or simultaneously; wherein the dielectric frame comprises a polyimide or a liquid crystal polymer.

[0016] The first adhesive composition and the second adhesive composition are a thermoplastic polyimide. Sometimes, the first adhesive composition and the second adhesive composition are cured simultaneously.

[0017] The curing can be performed at a temperature of about 220°C and a pressure of about 10 psi. The flange may be formed of a copper substrate plated with gold.

[0018] Sometimes, the methods can further comprise attaching a die to the upper surface of the flange, wherein the dielectric frame surrounds the die.

[0019] Also disclosed are methods for forming an air cavity package, comprising: receiving a polyimide sheet laminated on a lower surface and an upper surface with a

CLAIMS:

1. An air cavity package adapted to contain a die, comprising:

a flange having an upper surface; and

a dielectric frame having an upper surface and a lower surface, the lower surface of the dielectric frame being attached to the upper surface of the flange via a thermoplastic polyimide;

wherein the dielectric frame is made of a polyimide or a liquid crystal polymer; and

a first conductive lead and a second conductive lead, attached to opposite sides of the upper surface of the dielectric frame, wherein the first conductive lead and the second conductive lead are attached to the upper surface of the dielectric frame by a thermoplastic polyimide.

2. The air cavity package of claim 1, wherein the first conductive lead and the second conductive lead are made of copper, nickel, a copper alloy, a nickel-cobalt ferrous alloy, or an iron-nickel alloy.

3. The air cavity package of claim 2, wherein the copper alloy is selected from the group consisting of CuW, CuMo, CuMoCu, and CPC.

4. The air cavity package of claim 1, wherein the flange is made of copper, a copper alloy, aluminum, an aluminum alloy, AlSiC, AlSi, Al/diamond, Al/graphite, Cu/diamond, Cu/graphite, Ag/diamond, CuW, CuMo, Cu:Mo:Cu, Cu:CuMo:Cu (CPC), Mo, W, metallized BeO, or metallized AlN.

5. The air cavity package of claim 1, wherein the flange is a substrate plated with one or more metal sublayers.

6. The air cavity package of claim 5, wherein the one or more metal sublayers are made of nickel (Ni), gold (Au), palladium (Pd), chromium (Cr), or silver (Ag).

7. The air cavity package of claim 1, wherein the dielectric frame further comprises a filler.

8. The air cavity package of claim 7, wherein the filler is selected from the group consisting of ceramic powder, glass powder, and chopped glass fibers.

9. The air cavity package of claim 1, wherein the dielectric frame has a dielectric constant of 3.0 to 5.0.

10. A method for forming an air cavity package, comprising:

joining a lower surface of a dielectric frame to an upper surface of a flange using a first thermoplastic polyimide;

joining a first conductive lead and a second lead to an upper surface of the dielectric frame using a second thermoplastic polyimide; and

curing the first thermoplastic polyimide and the second thermoplastic polyimide, either separately or simultaneously;

wherein the dielectric frame comprises a polyimide or a liquid crystal polymer.

11. The method of claim 10, wherein the first thermoplastic polyimide and the second thermoplastic polyimide are cured simultaneously.

12. The method of claim 10, wherein the curing is performed at a temperature of about 220°C and a pressure of about 10 psi.

13. The method of claim 10, wherein the flange is formed of a copper substrate plated with gold.

14. The method of claim 10, further comprising attaching a die to the upper surface of the flange, wherein the dielectric frame surrounds the die.