

FLEXIBLE CIRCUITS WITH COPLANAR CONDUCTIVE FEATURES AND METHODS OF MAKING SAME

Field

5 The present invention relates to flexible LED assemblies that have co-planar integrated conductive features upon which an LED can be mounted, and to methods of making such LED assemblies.

Background

10 Flexible circuits and assemblies are often used as connectors in various applications of electronics equipment, such as printers, computers, monitors and the like. Such circuits offer a benefit over previously used rigid circuit boards in both flexibility and space savings.

 Where LEDs are attached to flexible circuits and assemblies, an attachment technique may be utilized. Various dies attachment techniques have been used for, e.g., flip chip dies, including eutectic bonding, which is attractive due to the need for less attachment material (and correspondingly, lower
15 cost). This type of bonding generally takes place through inter-metallic bonding of gold and tin. However, despite the advantages of the bonding process, it requires a high level of coplanarity between adjacent conductors to which a common LED is being attached. This is a solution the present description provides.

Summary

20 In one aspect, the present invention provides description relates to a flexible LED assembly. The flexible LED assembly includes a flexible polymer substrate, a first conductive feature, a second conductive feature and an LED. The first conductive feature is positioned both within the flexible substrate and also on a surface of the flexible substrate. The second conductive feature is positioned both within the flexible substrate and on a surface of the flexible substrate as well. The first and second
25 conductive features are separated by a gap therebetween. The LED is mounted on both the first and second conductive features, and the first and second conductive features are substantially coplanar with one another.

 In another aspect, the present invention provides description relates to a method of making a flexible LED assembly. The method includes the steps of providing a first substrate; applying a
30 conductive metal layer on a first surface of the substrate; applying a resist to first areas of a surface of the conductive metal layer that is opposite the surface in contact with the first surface of the substrate, and to second areas of the second surface of the substrate, the first areas and second areas being different areas of the surfaces laterally; etching the areas of the conductive metal layer uncovered by the photo-resist until only a thin layer of the conductive metal layer remains in those areas; milling the second areas of the
35 second surface of the substrate until the areas expose the conductive metal layer, creating vias in the substrate; removing the resist in first and second areas; filling the vias with conductive metal that is an equivalent metal to the conductive metal layers; and removing the thin layer of conductive metal layer remaining in the areas that were previously etched.

In yet another aspect, the present ~~invention provides description relates to~~ a second method of making a flexible LED assembly. The method includes the steps of providing a first substrate; applying a conductive metal layer on a first surface of the substrate; applying a film layer to the entire surface of the conductive metal layer that is opposite the surface in contact with the first surface of the substrate, and to the entire surface of the second surface of the substrate, the second surface being opposite the first surface; removing portions of the film layer on both the conductive metal layer surface and second surface of the substrate; applying additional metal material over the areas of the conductive metal layer in those areas where the film layer has been removed; etching the areas of the substrate where the film has been removed until the areas expose the conductive metal layer, creating vias in the substrate; removing the remaining film on the conductive metal layer; filling the vias with conductive metal that is an equivalent metal to the conductive metal layers; and etching the portion of the conductive metal layer that had been positioned underneath the film until the conductive metal in the vias is exposed.

In another aspect, the present ~~description relates to invention provides~~ an article. The article includes a flexible dielectric polymeric substrate having a first major surface and a second major surface. The first major surface has a conductive layer thereon. The flexible dielectric polymer layer further includes two vias extending from the second major surface to the first major surface. The two vias contain conductive material. The conductive layer includes electrically separated first and second portions configured to support and electrically connect a light emitting semiconductor device to the conductive layer. Finally, the first and second portions are substantially coplanar with one another.

Brief Description of the Drawings

Figure 1 is a cross-sectional view of a flexible LED assembly according to the present description.

Figure 2 is a cross-sectional view of a flexible LED assembly according to the present description.

Figure 3 is a flow chart of a method of making a flexible LED assembly according to the present description.

Figure 4 is a flow chart of a method of making a flexible LED assembly according to the present description.

Figure 5 is a cross-sectional view of a flexible LED assembly according to the present description.

Figure 6 is a cross-sectional view of an article according to the present description.

The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number.

Detailed Description

In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings, which illustrate specific embodiments in which the invention may be practiced.

etching the areas of the conductive metal layer uncovered by the photo-resist until only a thin layer of the conductive metal layer remains in those areas,

milling the second areas of the second surface of the substrate until the areas expose the conductive metal layer, creating vias in the substrate,

removing the resist in first and second areas,

filling the vias with conductive metal that is an equivalent metal to the conductive metal layers, and

removing the thin layer of conductive metal layer remaining in the areas that were previously etched.

9. The method of claim 8, wherein milling the second areas comprises chemical milling.

10. The method of claim 8, wherein removing the thin layer comprises flash etching the thin layer.

11. The method of claim 8, wherein the conductive metal layer is applied using a sputtering and flash plating process.

129. A method of making a flexible LED assembly, comprising:

providing a first substrate,

applying a conductive metal layer on a first surface of the substrate,

applying a film layer to the entire surface of the conductive metal layer that is opposite the surface in contact with the first surface of the substrate, and to the entire second surface of the substrate, the second surface being opposite the first surface,

removing portions of the film layer on both the conductive metal layer surface and second surface of the substrate,

applying additional metal material over the areas of the conductive metal layer in those areas where the film layer has been removed,

etching the areas of the substrate where the film has been removed until the areas expose the conductive metal layer, creating vias in the substrate,

removing the remaining film on the conductive metal layer,

filling the vias with conductive metal that is an equivalent metal to the conductive metal layers, and

etching the portion of the conductive metal layer that had been positioned underneath the film until the conductive metal in the vias is exposed.

13. The method of claim 12, wherein the conductive metal layer is applied using a sputtering and flash plating process.

14. The method of claim 12, wherein etching the portion of the conductive metal layer that had been positioned underneath the film comprises a flash etching process.

150. An article comprising:

a flexible dielectric polymeric substrate having a first major surface with a conductive layer thereon and having a second major surface, the flexible dielectric polymer layer having two vias extending from the second major surface to the first major surface, the two vias containing conductive material, the conductive layer including electrically separated first and second portions configured to support and electrically connect a light emitting semiconductor device to the conductive layer, wherein the first and second portions are substantially coplanar with one another.