

LIGHT EMITTING MIRROR STRUCTURE

TECHNICAL FIELD

5 This invention relates generally to a light emitting mirror structure and a method for forming thereof.

Background

10 Building owners, architects and passers-by have always been fascinated not only by façade lighting and the splendor it creates, but have found it useful for conveying message, creating attention and portraying a positive message. There are different ways to illuminate a building on the inside or on the building's exterior, either on opaque or glass surfaces. However, illuminating a glass surface is not as easy as compared to opaque surfaces.

15 Glass surfaces are typically lighted up with third party light sources either with light emitting diodes (LED) bulbs or lamps from other traditional lighting media. When this is implemented on decorative glass or mirror glass, the effects are glaring lighting that are harsh on the eyes and may not be functionally effective in interior designs, for example, when used with mirrors on furniture, in washroom, powder rooms or vanity areas. As in most cases, glass and lights operate as two distinct functional elements, each with their own
20 function with high sunken cost. The combination of glass and light into a single media of light emitting glass provides the cost advantage of providing a functional glass material while emitting soft glowing light directly from its surfaces. Therefore, there exists a need for a scalable, easily manufacturable large area forming method for lighted mirror structures.

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Summary

In accordance with a first aspect of the invention, there is disclosed a light emitting mirror structure comprising a first substrate, the first substrate being a conductive substrate, a first contact pad disposed over the first substrate and an interpose layer formed over the first substrate. The interpose layer comprising a light emitting material and a dielectric layer formed along the light emitting material. The light emitting mirror structure further comprises a first electrode layer formed over the interpose layer with the light emitting material interposing the dielectric layer and the first electrode layer, the first contact pad being spatially displaced from the interpose layer, a second contact pad disposed over the first electrode layer, a resin layer extending over the first electrode layer with the second contact pad interposing the interpose layer and the resin layer, and a second substrate disposed over the resin layer with the resin layer interposing the first substrate and the second substrate, the second substrate being a mirror substrate having a reflective face configured for facing the interpose layer.

In accordance with a second aspect of the invention, there is disclosed a light emitting mirror structure forming method comprising forming an interpose layer over a first substrate. The first substrate being a conductive substrate and the interpose layer comprising a light emitting material and a dielectric layer formed along the light emitting material. The light emitting mirror structure forming method further comprises forming a first electrode layer over the interpose layer for disposing the light emitting material between the dielectric layer and the first electrode layer, the first contact pad being spatially displaced from the interpose layer, forming a first contact pad on the first substrate, the first contact pad being spatially displaced from the interpose layer, forming a second contact pad on the first electrode layer, forming a resin layer over the first electrode layer, and disposing a second substrate over the interpose layer and the second contact pad, the second substrate being a mirror substrate having a reflective face configured for facing the interpose layer.

Brief Description of the Drawings

FIG. 1 shows an exemplary partial sectional view of a light emitting mirror structure in accordance with one aspect of the invention;

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FIG. 2 shows an exemplary process flow diagram of a light emitting mirror structure forming method for forming at least a portion of the light emitting mirror structure of FIG. 1 in accordance with another aspect of the invention; and

- 10 FIG. 3 shows an exemplary partial sectional view of the light emitting mirror structure of FIG. 1 with a first extension line extending from a first contact pad and a second extension line extending from a second contact pad.

Detailed Description

An exemplary embodiment of the present invention, a light emitting mirror structure 20 and a light emitting mirror structure forming method 100 is described hereinafter with reference to FIG. 1 to FIG. 3.

The light emitting mirror structure 20 comprises a first substrate 22. Specifically, the first substrate 22 is a conductive substrate. The light emitting structure 20 further comprises a first contact pad 24 disposed over the first substrate 22, and an interpose layer 28 formed over the first substrate 22. The interpose layer 28 comprises a light emitting material 30, and a dielectric layer 32 formed along the light emitting material 32. The light emitting mirror structure 20 further comprises a first electrode layer 34 formed over the interpose layer 28 with the light emitting material 30 interposing the dielectric layer 32 and the first electrode layer 34. The first contact pad 24 is spatially displaced from the interpose layer 28. Preferably, each of the first electrode layer 34, the light emitting material 30 and the dielectric layer 32 is formed by one of jet spray printing and screen printing. The interpose layer 28 can be formed with various shapes and patterns. Hence, in this manner, the light emitting mirror structure 20 is provided for use in displays, advertising, vanity areas, on furniture or other visual display applications.

The light emitting mirror structure 20 further comprises a second contact pad 36 disposed over the interpose layer 28, a resin layer 40 extending over the interpose layer 28 with the second contact pad 36 interposing the interpose layer 28 and the resin layer 40, and a second substrate 42 disposed over the resin layer 40 with the resin layer 40 interposing the first substrate 22 and the second substrate 42. Preferably, the second substrate 42 is a mirror substrate having a reflective face configured for facing the interpose layer 28.

Preferably, the first substrate 22 is a glass substrate 43a having a second electrode layer 43b being formed thereon. Each of the first electrode layer 34 and the second electrode layer 43b is formed from conductive oxides, such as at least one of conductive zinc oxide, indium tin oxide and silver paste.

Further, preferably, the resin layer 40 is a polyvinyl butyral (PVB) layer. Each of the first substrate 22 and the second substrate 42 is a rigid structure that is substantially optically transparent. Preferably, each of the first contact pad 24 and the second contact pad 36 is formed from silver paste, or one of a copper sheet and a copper plate structure. For example, a patterned portion of a copper sheet or a copper plate can be cut to form the first contact pad 24 and the second contact pad 36. Hence, each of the first contact pad 24 and the second contact pad 36 can be a malleable strip of copper of a required shape and dimension or a flexible sheet of copper.

The first electrode layer 34 may be formed or provided as a meshed-patterned electrode to reduce cost and integration of the light emitting material 30 and the dielectric layer 32 therewith for increased usability. The interpose layer 28 may be encapsulated during the manufacturing thereof. Advantageously, the interpose layer 28 may be encapsulated with one of PVB or conductive adhesive such as anisotropic conductive adhesive (ACA) so that the printed light emitting mirror structure 20 has increased lifetime and mechanical robustness.

One of the light emitting material 30 and dielectric layer 32 is formed on the first substrate 22 and interposing the first substrate 22 and the other thereof. The dielectric layer 32 is formed from ceramic paste and the light emitting material 30 is phosphor paste. Preferably, the dielectric layer 32 is formed from ceramic paste or barium titanate composite, and the light emitting material 30 is formed from phosphor paste or doped zinc sulfide.

Preferably, the light emitting mirror structure 20 further comprises a first connection line 44 embedded in the resin layer 40 with one end thereof extending out of the resin layer 40 adjacent the first contact pad 24 for electrically coupling with the first contact pad 24 and the other end thereof extendable from an edge of the resin layer 40. The one end of the first connection line 44 can be bonded directly to the first contact pad 24. The light emitting mirror structure 20 further comprises a second connection line 46 embedded in the resin

layer 40 with one end thereof extending out of the resin layer 40 adjacent the second contact pad 36 for electrically coupling with the second contact pad 36 and the other end thereof extendable from an edge of the resin layer 40. The one end of the second connection line 46 can be bonded directly to the second contact pad 36. The resin layer 40 can be formed as one or multiple layers with the first connection line 44 and the second connection line 46, or a portion of each thereof, being embedded therein during forming of the resin layer 40 or sandwiched between two layers of the resin layer 40. Preferably, the second substrate 42 has at least one pattern 47 etched thereinto. The at least one pattern 47 may be decorative in nature or optically functional and is preferably done along one face of the second substrate 42.

In an implementation of the light emitting mirror structure forming method 100 and the light emitting mirror structure, one or both of the first connection line 44 and the second connection line 46 can be bonded directly to, respectively, the first contact pad 24 and the second contact pad 36 prior to the first contact pad 24 and the second contact pad 36 being bonded to the first substrate 22 and the interpose layer 28 respectively. The first connection line 44 and the second connection line 46 is specifically where through power, or electrical energy, is supplied to the interpose layer 28.

The light emitting mirror structure forming method 100 comprises a step 102 of forming the interpose layer 28 over the first substrate 22, a step 103 of forming a first electrode layer 34 over the interpose layer 28 for disposing the light emitting material 30 between the dielectric layer 32 and the first electrode layer 34, a step 104 of forming the first contact pad 24 on the first substrate 22, and a step 106 of forming the second contact pad 36 on the first electrode layer 34. The light emitting mirror structure forming method 100 further comprises a step 108 of forming the resin layer 40 over the first electrode layer 34, and a step 110 of disposing a second substrate 42 over the interpose layer 28 and the second contact pad 36.

The light emitting mirror structure forming method 100 further comprises a step 200 of pre-forming the second electrode layer 43b over the glass substrate 43a to thereby obtain the

first substrate 22. Preferably, the step 104 of forming the first contact pad 24 on the first substrate 22, and the step 106 of forming the second contact pad 36 on the first electrode layer 34 may be performed at the same time, for example in one screen print step.

- 5 In an example of implementation of the light emitting mirror structure forming method 100, operating temperatures of substantially between 20 °C to 30 °C and operating humidity of substantially between 39% to 76% are preferred. Prior to the utilization of any of the first substrate 22 and the second substrate 42, each of the first substrate 22 and the second substrate 42 needs to be prepared by first being cut into the required size, being heated in an oven at 140°C for 1 hour and then being cooled, preferably in the same oven, until the temperature of the oven reaches 60°C. Further, the first substrate 22 may be surface treated or coated to enable the first substrate 22 to be electrically conductive.

The first electrode layer 34 may be formed by screen printing silver paste at 40mm/s to 70mm/s at a pressure of 0.24MPa before being cured in an oven for 130°C for 20mins and subsequently inspected for broken traces, unintended voids and that a thickness of 6-8μm for the first electrode layer 34 has been achieved.

For the dielectric layer 32, dielectric material is preferably screen printed at 40mm/s to 70mm/s at a pressure of 0.24MPa before being cured in an oven for 130°C for 20mins and subsequently inspected for unintended voids and that a thickness of 20μm for the dielectric layer 32 has been achieved. For the light emitting material 30, dielectric material is preferably screen printed at 40mm/s to 70mm/s at a pressure of 0.24MPa before being cured in an oven for 130°C for 20mins and subsequently inspected for unintended voids and that a thickness of 30μm for the light emitting material 30 has been achieved. Inspection for voids and broken traces are preferably performed using one or both of a light box and an optical microscope.

Embodiments of the present printed light emitting mirror structure 20 can provide large area lighting, large area signage, or large area display, on furniture, in vanity applications such as

in washrooms, powder rooms or the like vanity areas, under both indoor and outdoor conditions. While several exemplary embodiments have been presented in the foregoing detailed description of the invention, it should be appreciated that a vast number of variations exist. The light emitting mirror structure 20 provides dual functions of having a reflective mirror in conjunction with having a lighted glow from the mirror for both lighting reasons, information display, for example the light emitting material may be shaped or modularised for displaying graphics or data, and for decorative purpose.

Aspects of particular embodiments of the present disclosure address at least one aspect, problem, limitation, and/or disadvantage associated with light emitting mirror structures and a method for forming thereof. While features, aspects, and/or advantages associated with certain embodiments have been described in the disclosure, other embodiments may also exhibit such features, aspects, and/or advantages, and not all embodiments need necessarily exhibit such features, aspects, and/or advantages to fall within the scope of the disclosure. It will be appreciated by a person of ordinary skill in the art that several of the above-disclosed structures, components, or alternatives thereof, can be desirably combined into alternative structures, components, and/or applications. In addition, various modifications, alterations, and/or improvements may be made to various embodiments that are disclosed by a person of ordinary skill in the art within the scope of the present disclosure, which is limited only by the following claims.

Claims

1. A light emitting mirror structure comprising:
 - a first substrate, the first substrate being a conductive substrate;
 - 5 a first contact pad disposed over the first substrate;
 - an interpose layer formed over the first substrate, the interpose layer comprising:
 - a light emitting material; and
 - a dielectric layer formed along the light emitting material;
 - 10 a first electrode layer formed over the interpose layer with the light emitting material interposing the dielectric layer and the first electrode layer, the first contact pad being spatially displaced from the interpose layer,
 - a second contact pad disposed over the first electrode layer;
 - a resin layer extending over the first electrode layer with the second contact pad interposing the interpose layer and the resin layer; and
 - 15 a second substrate disposed over the resin layer with the resin layer interposing the first substrate and the second substrate, the second substrate being a mirror substrate having a reflective face configured for facing the interpose layer.
- 20 2. The light emitting mirror structure as in claim 1, the first substrate being a glass substrate having a second electrode layer being formed thereon.
3. The light emitting mirror structure as in claim 2, each of the first electrode layer and the second electrode layer being formed from at least one of conductive zinc oxide,
 - 25 indium tin oxide and silver paste.
4. The light emitting mirror structure as in claim 1, the resin layer being a polyvinyl butyral (PVB) layer.
5. The light emitting mirror structure as in claim 1, each of the first contact pad and the
 - 30 second contact pad being formed from one of silver paste and a copper sheet.

6. The light emitting mirror structure as in claim 1, the dielectric layer being formed from ceramic paste and the light emitting material being phosphor paste.

7. The light emitting mirror structure as in claim 1, further comprising:

5 a first connection line embedded in the resin layer with one end thereof extending out of the resin layer adjacent the first contact pad for electrically coupling with the first contact pad and the other end thereof extendable from an edge of the resin layer; and

10 a second connection line embedded in the resin layer with one end thereof extending out of the resin layer adjacent the second contact pad for electrically coupling with the second contact pad and the other end thereof extendable from an edge of the resin layer.

15 8. The light emitting mirror structure as in claim 1, the second substrate having at least one pattern etched thereinto.

9. A light emitting mirror structure forming method comprising:

 forming an interpose layer over a first substrate, the first substrate being a conductive substrate and the interpose layer comprising:

20 a light emitting material; and

 a dielectric layer formed along the light emitting material;

 forming a first electrode layer over the interpose layer for disposing the light emitting material between the dielectric layer and the first electrode layer, the first contact pad being spatially displaced from the interpose layer;

25 forming a first contact pad on the first substrate, the first contact pad being spatially displaced from the interpose layer;

 forming a second contact pad on the first electrode layer;

 forming a resin layer over the first electrode layer; and

disposing a second substrate over the interpose layer and the second contact pad, the second substrate being a mirror substrate having a reflective face configured for facing the interpose layer.

- 5 10. The light emitting mirror structure forming method as in claim 9, further comprising:
 pre-forming a second electrode layer over a glass substrate to thereby obtain
 the first substrate.
- 10 11. The light emitting mirror structure forming method as in claim 10, each of the first
 electrode layer and the second electrode layer being formed from at least one of
 conductive zinc oxide, indium tin oxide and silver paste.
- 15 12. The light emitting mirror structure forming method as in claim 9, the resin layer
 being a polyvinyl butyral (PVB) layer, and each of the first contact pad and the
 second contact pad being formed from one of silver paste and a copper sheet,
 wherein the dielectric layer is formed from ceramic paste and the light
 emitting material is formed from phosphor paste.
- 20 13. The light emitting mirror structure forming method as in claim 9, further comprising:
 embedding a first connection line in the resin layer with one end thereof
 extending out of the resin layer adjacent the first contact pad for electrically coupling
 with the first contact pad and the other end thereof extendable from an edge of the
 resin layer; and
- 25 embedding a second connection line in the resin layer with one end thereof
 extending out of the resin layer adjacent the second contact pad for electrically
 coupling with the second contact pad and the other end thereof extendable from an
 edge of the resin layer.

14. The light emitting mirror structure forming method as in claim 9, further comprising:
etching at least one pattern into the second substrate prior to disposing the second substrate over the interpose layer and the second contact pad.