

DISPLAY ASSEMBLY

Field of the Invention

5

This invention relates generally to display assemblies. In particular, this invention relates to, but is not necessarily limited by, a display assembly having a substrate with a semiconductor device mounted thereon.

10

Background of the Invention

Display assemblies having substrates with semiconductor devices
15 mounted thereon are known in the art. Each of these assemblies typically include a display having a substrate on which one or more semiconductor devices are mounted. For example, a driver for driving a liquid crystal display (LCD) can be mounted on a glass or plastics substrate attached to the display. Conventionally, the LCD has a layer of liquid crystals
20 sandwiched between two transparent layers. One of the two transparent layers serve as the substrate and the other as a window through which information displayed is viewed. Electrical signals from the driver are carried on conductors that are formed on the window and the substrate with a transparent material such as indium oxide (ITO). These signals
25 either control the liquid crystals to provide the information or are provided to other semiconductor devices such as a processor. Some of these other semiconductor devices may be mounted elsewhere and not on the same substrate as the driver. An interconnect is usually needed to carry such signals to the driver from the other semiconductor devices. This
30 interconnect typically has conductors formed on a flexible substrate. Examples of semiconductor devices mounted on substrates of LCDs are describe in US Patents 5,467,210 and 5,576,868.

It is known in the art that resistance of conductors can adversely affect electrical signals between semiconductor devices. Conductors made with
35 transparent materials, such as ITO, typically have higher electrical resistance compared with non-transparent conductive materials, such as gold or copper. One technique to reduce this resistance is to plate portions



of those conductors that need not be transparent with non-transparent conductive materials. Another technique is to make transparent conductors thicker so as to improve their conductivity. However, both techniques require more materials and such materials are known to be expensive.

- 5 Another problem is that both techniques require additional process steps to improve the conductivity of the conductors and such steps add cycle time in manufacturing display assemblies.

10 Summary of the Invention

It is an object of this invention to overcome or at least alleviate at least one of the problems associated with display assemblies.

- 15 According to one aspect of the invention, there is provided a display assembly, said assembly comprising:

- a display having a window and a substrate;
- a semiconductor device mounted on said substrate and having a plurality of conductive pads for external interconnections, some of said
- 20 pads being coupled to said display; and
- a flexible interconnect having a plurality of conductors, wherein at least some of said conductors are connected to at least some of said pads.

- 25 Preferably, said flexible interconnect can have a portion, said portion being sandwiched between said semiconductor device and said substrate.

- Alternatively, said substrate can comprise a ledge for mounting said semiconductor device, said ledge extending beyond a section of the
- 30 perimeter of said window.

Suitably, said flexible interconnect can have a portion, said portion being sandwiched between said semiconductor device and said ledge.

- 35 Preferably, said conductors can be on a side of said flexible interconnect, said side being opposite to said conductive pads.



Alternatively, said conductors can be on a side of said flexible interconnect, said side facing said conductive pads.

5 Alternatively, said conductors can be exposed on an edge of said flexible interconnect, said edge abutting said conductive pads.

Preferably, said semiconductor device can comprise a driver for driving said display.

10 Suitably, said display can be a liquid crystal display.

According to another aspect of the invention, there is provided a method for assembling a display assembly, said method comprising the steps of:

15 providing a display having a window and a substrate; and mounting a device assembly on said substrate, said device assembly having a semiconductor device mounted to a flexible interconnect, said semiconductor device having a plurality of conductive pads for external
20 interconnections, some of said pads being for coupling to said display, said flexible interconnect having a plurality of conductors, at least some of said conductors are connected to at least some of said pads.

Preferably, said step of mounting can comprise the step of placing a
25 portion of said flexible interconnect between said semiconductor device and said substrate.

Suitably, said step of mounting can comprise the step of placing a portion of said flexible interconnect between said semiconductor device
30 and a ledge of said substrate, said ledge extending beyond a section of the perimeter of said window.

Brief Description of the Drawings

In order to describe the invention and to put it into practical effect, reference will now be made to preferred embodiments as illustrated with
5 reference to the accompanying drawings in which:

FIG. 1 shows a side view of a display assembly in accordance with a preferred embodiment of the invention;

10 FIG. 2 shows a plan view of the display assembly of FIG. 1;

FIGs. 3a, 3b and 3c show assembly of a first embodiment of a device assembly for the display assembly of FIG. 1;

15 FIG. 4 shows a second embodiment of a device assembly for the display assembly of FIG. 1; and

FIGs. 5a and 5b show assembly of a third embodiment of a device assembly for the display assembly of FIG. 1;

20

FIG. 6 shows a side view of a display assembly in accordance with an alternate preferred embodiment of the invention;

FIG. 7 shows a plan view of the display assembly of FIG. 6;

25

FIG. 8 shows a side view of a device assembly for the display assembly of FIG. 6; and

FIG. 9 shows the device assembly of FIG. 8 when mounted to a portion
30 of the display assembly of FIG. 6.

FIG. 10 shows a plan view of a display assembly in accordance with another alternate preferred embodiment of the invention.

Detailed Description of the Invention

FIG. 1 shows a side view of a display assembly 1 in accordance with a preferred embodiment of the invention. Display assembly 1 comprises a display 2, a semiconductor device 3 and a flexible interconnect 4. Display 2 can be, for example, a liquid crystal display. Display 2 has a window 5 and a substrate 6. Semiconductor device 3 can be, for example, a driver for driving display 2. Semiconductor device 3 is mounted on substrate 6 and has a plurality of conductive pads for external interconnections. Pads 7,8 of the plurality of conductive pads are indicated in FIG. 1. Pad 7 is coupled to display 2. Flexible interconnect 4 has a plurality of conductors. Some of these conductors are connected to at least some of the conductive pads.

FIG. 2 shows a plan view of display assembly 1. Substrate 2 comprises a ledge 9 for mounting semiconductor device 3. Ledge 9 extends beyond a section 10 of the perimeter of window 5. As shown in FIG. 2, section 10 is an edge of window 5. In this preferred embodiment of the invention, a portion of flexible interconnect 4 is sandwiched between semiconductor device 3 and ledge 9. Also shown in FIG. 2 is the plurality of conductors of flexible interconnect 4 disposed on an interconnect substrate 11. Two conductors 12,13 are indicated. Some of these conductors are connected to at least some of the conductive pads of semiconductor device 3. Signals between display 2 and semiconductor device 3 are carried on substrate conductors formed on substrate 6. Two substrate conductors 14,15 are indicated in FIG. 2.

As shown in FIGs. 1 and 2, the invention eliminates substrate conductors between flexible interconnect 4 and semiconductor device 3. Such substrate conductors are formed as shown in prior art display assemblies such as described in US patents 5,467,210 and 5,576,868. Hence, the invention is advantageous over prior art display assemblies in two aspects. First, the invention reduces degradation of signals to semiconductor device 3 due to substrate conductors serving as an interconnecting media. Second, the invention allows a reduction in the width of ledge 9 as space for such substrate conductors is no longer

needed. Therefore, this invention provides for a cheaper and smaller display assembly 1 than prior art display assemblies.

FIGs. 3 to 5 show side views of different embodiments of a device assembly comprising semiconductor device 3 and flexible interconnect 4. These embodiments provide examples of how semiconductor device 3 and flexible interconnect 4 can be assembled prior to mounting the device assembly on substrate 6.

FIGs. 3a, 3b and 3c show assembly of a first embodiment of a device assembly for display assembly 1. This first embodiment is applied when conductors of flexible interconnect 4 are on a side opposite to conductive pads of semiconductor device 3. In this embodiment, a conductor 16 of flexible interconnect 4 and a pad 17 of semiconductor device 3 are used as an example to show how the device assembly can be assembled.

In FIG. 3a, a portion 18 of flexible interconnect 4 is positioned next to semiconductor device 3 such that conductor 16 abuts pad 17. Portion 18 includes an aperture 19 through which a connecting media, such as solder, can be deposited. Another portion 20 of conductor 16 may be insulated by a protective layer 21. Flexible interconnect 4 has an interconnect substrate 22 for supporting conductors.

FIG. 3b shows deposition of solder 23 into aperture 19. Deposition of solder 23 can be by methods known in the art such as thermosonic bumping.

FIG. 3c shows flattening of solder 23 at portion 18 of conductor 16. Solder 23 forms a connection 24 to conductor 16 as indicated. Although FIGs. 3a and 3b show deposition and flattening of solder 23 as two different process steps in connecting conductor 16 to pad 17, such steps may be combined into a single process step as when equipment for the thermosonic bumping also has features to flatten solder 23.

FIG. 4 shows a second embodiment of a device assembly for display assembly 1. This second embodiment is applied when conductors of flexible interconnect 4 are on a side facing conductive pads of semiconductor device 3. In this embodiment, a conductor 25 of flexible interconnect 4 and a pad 26 of semiconductor device 3 are used as an example to show how the device assembly can be formed. A connecting

media, such as solder, can be deposited on pad 26. This solder is then heated by methods known in the art to form a connection 27 between conductor 25 and pad 26. Also shown in FIG. 4 is an interconnect substrate 28 for supporting conductors, such as conductor 25, of flexible interconnect 4. Portions of such conductors may be insulated by a protective layer 29.

FIGs. 5a and 5b show assembly of a third embodiment of a device assembly for display assembly 1. This third embodiment is applied when conductors of flexible interconnect 4 are exposed on an edge abutting conductive pads of semiconductor device 3. In this embodiment, a conductor 30 of flexible interconnect 4 and a pad 31 of semiconductor device 3 are used as an example to show how the device assembly can be formed. Also shown in FIG. 4 is an interconnect substrate 32 that supports conductors, such as conductor 30, of flexible interconnect 4. A connecting media, such as solder, can be deposited on pad 31. When this solder is heated by methods known in the art, a connection 33 is formed between conductor 30 and pad 31.

Assembling display assembly 1 requires providing display 2 and mounting one of the various embodiments of the device assembly to substrate 6. The mounting comprises placing the portion of flexible interconnect 4 between semiconductor device 3 and ledge 9. An interconnecting media such as a non-conductive adhesive can be used for the mounting. This interconnecting media is applied in portions of ledge 9 underneath semiconductor device 3. Pad 8 will need a conductive interconnecting media such as solder or a conductive adhesive when a connection to one or more of the substrate conductors, such as substrate conductors 14,15, is needed. The connection is formed when the conductive interconnecting media is set.

FIG. 6 shows a side view of a display assembly 35 in accordance with an alternate preferred embodiment of the invention. In this alternate embodiment of the invention, a portion 38 of flexible interconnect 4 is also sandwiched between semiconductor device 3 and ledge 9. As in display assembly 1, some conductors are connected to at least some of the conductive pads, such as pads 36,37, of semiconductor device 3.

FIG. 7 shows a plan view of display assembly 35. In this plan view, semiconductor device 3 is mounted to ledge 9 of substrate 6 through portion 38.

5

FIG. 8 shows a side view of a device assembly for display assembly 35 comprising semiconductor device 3 and flexible interconnect 4. Pads 36,37 are shown as examples of how semiconductor device 3 can be assembled with flexible interconnect 4 to form the device assembly. As shown in FIG. 8, pads 36,37 are connected to conductors 39,40, respectively, of flexible interconnect 4 with an interconnecting media such as solder or an adhesive conductive. Connections 41,42 are formed when the interconnecting media is set. For example, when solder is used, thermocompression is one method to melt the solder to form connections 41,41. Also shown in FIG. 8 are interconnect substrate at portions 43,44 of flexible interconnect 4 in which conductors 39,40 are supported.

FIG. 9 shows the device assembly of FIG. 8 when mounted to portion 38 of display assembly 35. As shown in FIG. 9, conductor 39 is connected to substrate conductor 45 on ledge 9 with an interconnecting media such as solder or an adhesive conductive. Connection 46 is formed when the interconnecting media is set. In addition, additional interconnecting media, such as a non-conductive adhesive 47, can be used for mounting the device assembly to ledge 9.

FIG. 10 shows a plan view of a display assembly 50 in accordance with another alternate preferred embodiment of the invention. In this alternate embodiment of the invention, a portion 48 of flexible interconnect 4 is also sandwiched between semiconductor device 3 and the back of substrate 6. As in display assemblies 1 and 35, some conductors are connected to at least some of the conductive pads. In display assembly 50, window 5 and substrate 6 can be of equal size. Hence, display assembly 50 is smaller than display assemblies 1 and 35.

35

Advantageously, the preferred embodiments of the invention eliminate substrate conductors that interconnect the conductors of flexible

interconnect 4 and the conductive pads of semiconductor device 3 in prior art display assemblies such as described in US Patent 5,467,210 or US Patent 5,576,868. Furthermore, these preferred embodiments do not require additional processes, such as thickening or plating substrate
5 conductors, to improve the conductivity of the conductors. Therefore, the invention provides for cheaper and smaller display assemblies than prior art display assemblies without adding cycle time in manufacturing.

Although the invention has been described with reference to preferred
10 embodiments, it is to be understood that the invention is not restricted to the preferred embodiments described herein.

We claim:



THIS SHEET HAS BEEN
REPLACED

10

Claims

1. A display assembly, said assembly comprising:
a display having a window and a substrate;
5 a semiconductor device mounted on said substrate and having a plurality of conductive pads for external interconnections, some of said pads being coupled to said display; and
a flexible interconnect having a plurality of conductors,
wherein at least some of said conductors are connected to at least
10 some of said pads.
2. The display assembly as claimed in Claim 1 wherein said flexible interconnect has a portion, said portion being sandwiched between said semiconductor device and said substrate.
15
3. The display assembly as claimed in Claim 1 wherein said substrate comprises a ledge for mounting said semiconductor device, said ledge extending beyond a section of the perimeter of said window.
- 20 4. The display assembly as claimed in Claim 3 wherein said flexible interconnect has a portion, said portion being sandwiched between said semiconductor device and said ledge.
5. The display assembly as claimed in Claim 1 wherein said
25 conductors are on a side of said flexible interconnect, said side being opposite to said conductive pads.
6. The display assembly as claimed in Claim 1 wherein said
conductors are on a side of said flexible interconnect, said side facing said
30 conductive pads.
7. The display assembly as claimed in Claim 1 wherein said conductors are exposed on an edge of said flexible interconnect, said edge abutting said conductive pads.
35
8. The display assembly as claimed in Claim 1 wherein said semiconductor device comprises a driver for driving said display.

This Sheet Has Been Replaced





THIS SHEET HAS BEEN
REPLACED

9. The display assembly as claimed in Claim 1 wherein said display is a liquid crystal display.

5

10. According to another aspect of the invention, there is provided a method for assembling a display assembly, said method comprising the steps of:

10 providing a display having a window and a substrate; and
mounting a device assembly on said substrate, said device
assembly having a semiconductor device mounted to a flexible
interconnect., said semiconductor device having a plurality of conductive
pads for external interconnections, some of said pads being for coupling to
said display, said flexible interconnect having a plurality of conductors, at
15 least some of said conductors are connected to at least some of said pads.

11. The method as claimed in Claim 10 wherein said step of
mounting comprises the step of placing a portion of said flexible
interconnect between said semiconductor device and said substrate.

20

12. The method as claimed in Claim 10 wherein said step of
mounting comprises the step of placing a portion of said flexible
interconnect between said semiconductor device and a ledge of said
substrate, said ledge extending beyond a section of the perimeter of said
25 window.

13. A display assembly comprising a display, a semiconductor
device and a flexible interconnect substantially as described herein with
30 reference to and as illustrated by the accompanying drawings.

14. A method for assembling a display assembly substantially as
described herein with reference to and as illustrated by the accompanying
35 drawings.

This Sheet Has Been Replaced

