US 20030048243A1

(19) United States
(12) Patent Application Publication (10) Pub. No.: US 2003/0048243 A1
Kwasnick (43) Pub. Date: Mar. 13, 2003

(54) COMPENSATING ORGANIC LIGHT EMITTING DEVICE DISPLAYS FOR TEMPERATURE EFFECTS

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(21) Appl. No.: 09/951,834

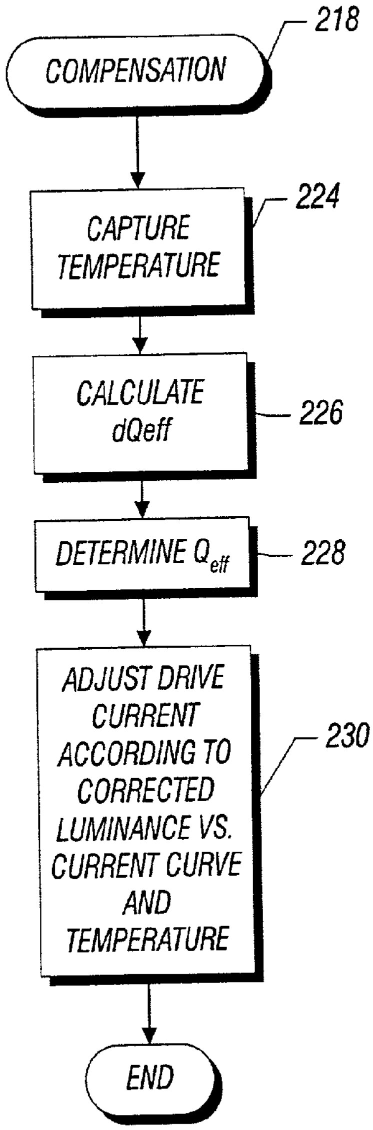
(22) Filed: Sep. 11, 2001

Publication Classification

(51) Int. Cl.[7] G09G 3/32
(52) U.S. Cl. 345/82

(57) ABSTRACT

A display may be driven to compensate for the effects of aging on the display. In particular, the temperature of the display may be determined on an ongoing basis and utilized to further correct total integrated charge for temperature effects.



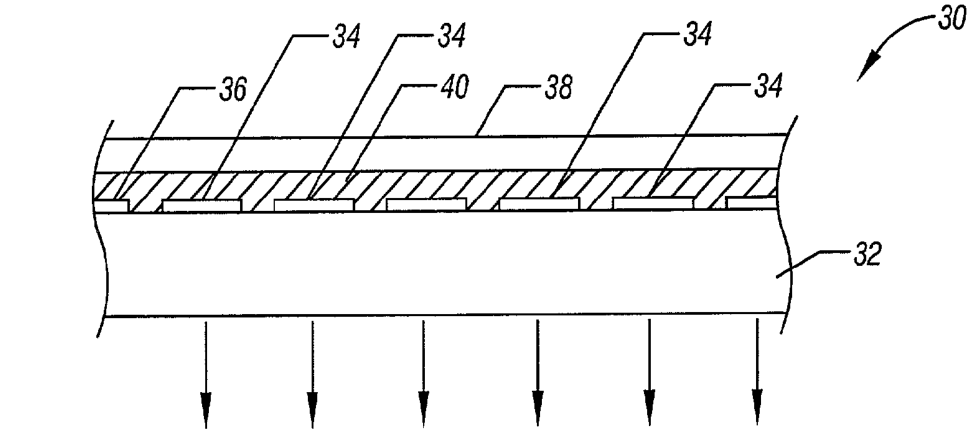


FIG. 1

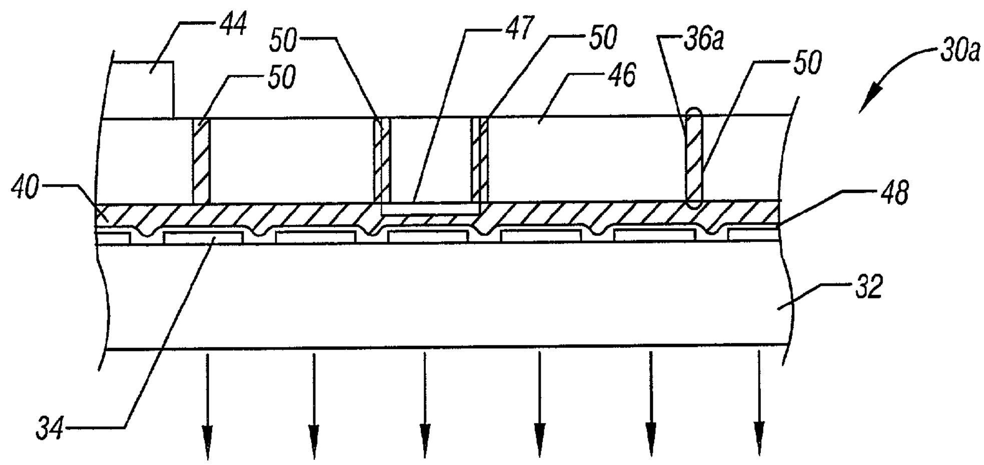


FIG. 2

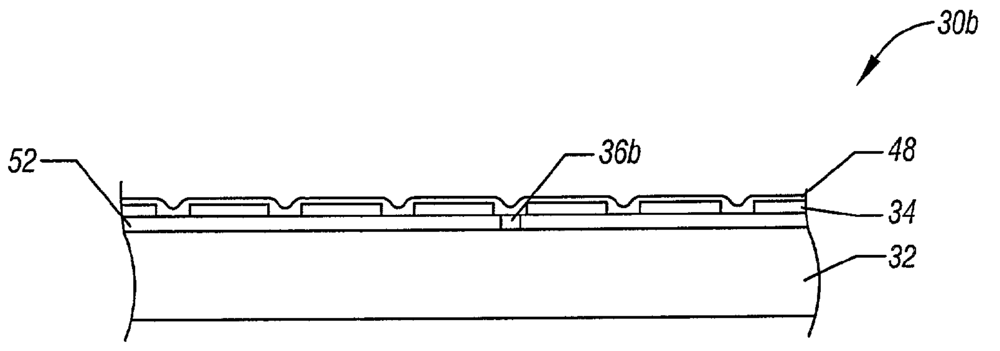


FIG. 3

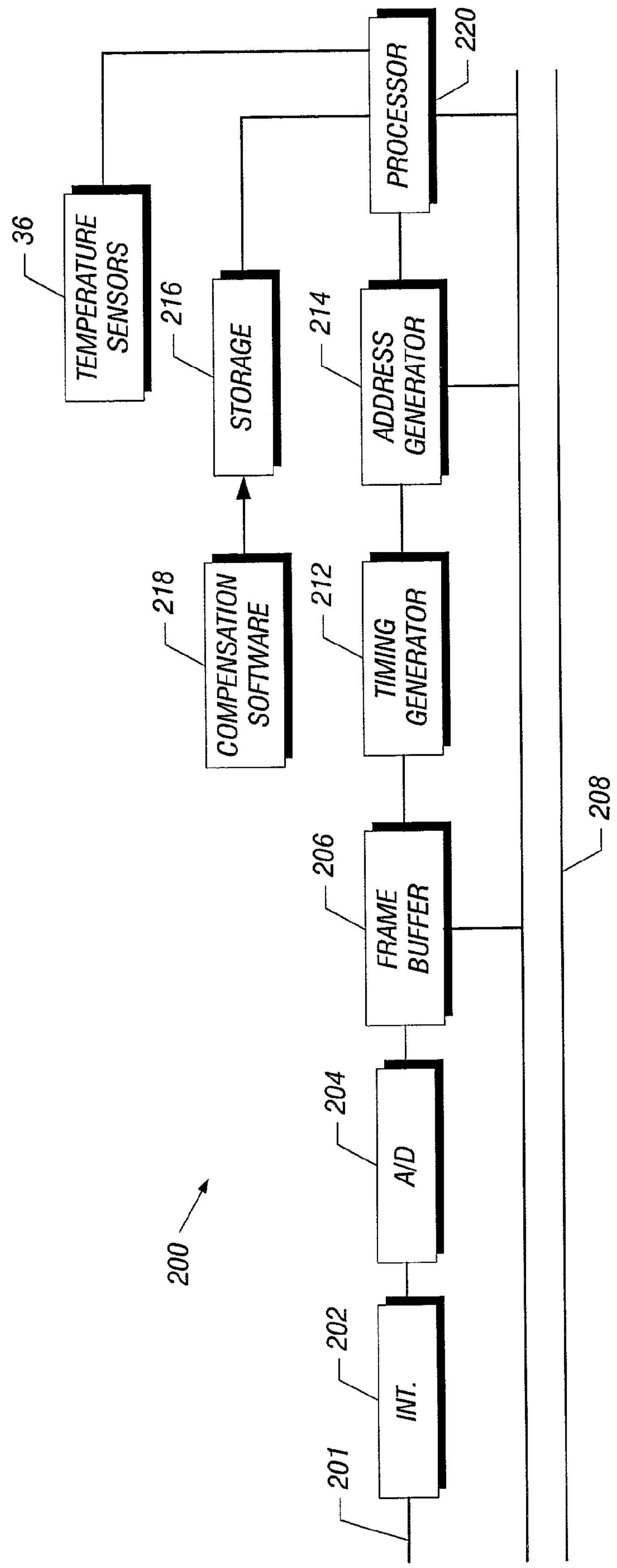

TEMPERATURE SENSORS
36
STORAGE
216
COMPENSATION SOFTWARE
218
PROCESSOR
220
ADDRESS GENERATOR
214
TIMING GENERATOR
212
FRAME BUFFER
206
A/D
204
INT.
202
201
200
208

FIG. 4

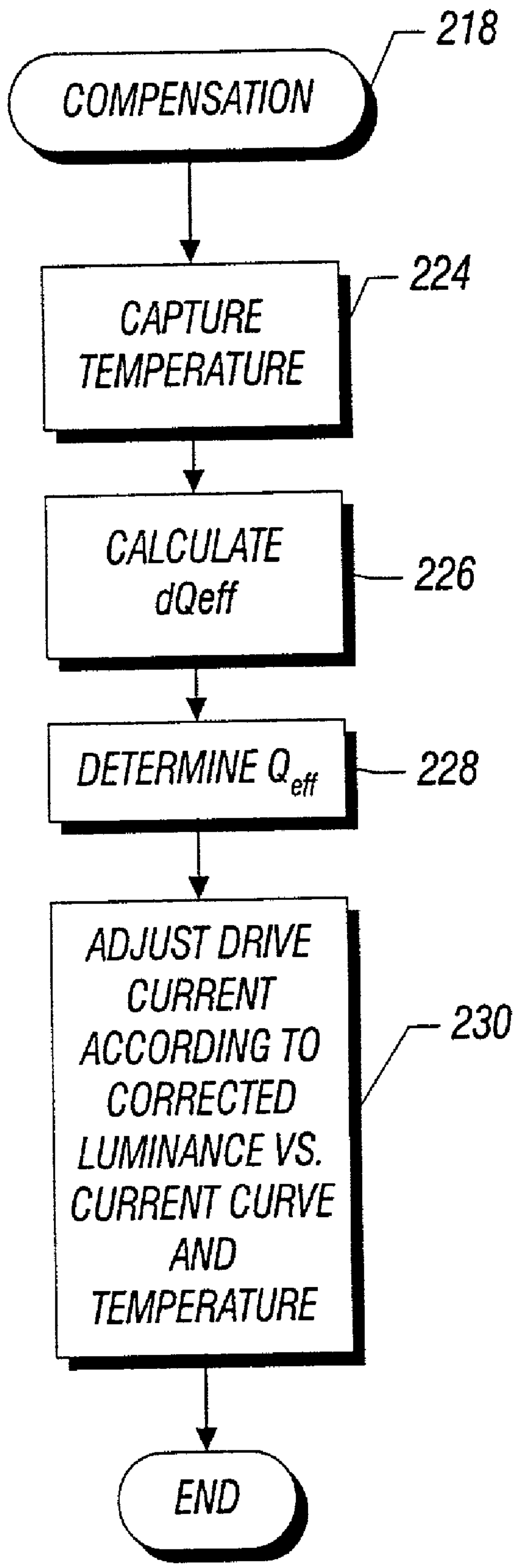

COMPENSATION
218
CAPTURE TEMPERATURE
224
CALCULATE dQeff
226
DETERMINE Q_{eff}
228
ADJUST DRIVE CURRENT ACCORDING TO CORRECTED LUMINANCE VS. CURRENT CURVE AND TEMPERATURE
230
END

FIG. 5

COMPENSATING ORGANIC LIGHT EMITTING DEVICE DISPLAYS FOR TEMPERATURE EFFECTS

BACKGROUND

[0001] This invention relates generally to organic light emitting device (OLED) displays that have light emitting layers.

[0002] OLED displays use layers of light emitting polymers or short molecule materials. Unlike liquid crystal devices, the OLED displays actually emit light making them advantageous for many applications.

[0003] Some OLED displays use at least one semiconductive conjugated polymer sandwiched between a pair of contact layers. Other OLED displays use small molecules. The contact layers produce an electric field that injects charge carriers into the light emitting layer. When the charge carriers combine in the light emitting layer, the charge carriers decay and emit radiation in the visible range.

[0004] It is believed that polymer compounds containing vinyl groups tend to degrade over time and use due to oxidation of the vinyl groups, particularly in the presence of free electrons. Since driving the display with a current provides the free electrons in abundance, the lifetime of the display is a function of total output light. Newer compounds based on fluorine have similar degradation mechanisms that may be related to chemical purity, although the exact mechanism is not yet well known in the industry. In general, OLED displays have a lifetime limit related to the total output light. This lifetime is a function of the display usage model.

[0005] The OLED display can be driven so as to increase its useful lifetime because as the display degrades, its output light is decreased. One way to drive the display to increase lifetime is to drive the display to increase the display's brightness. However, degradation may introduce output non-uniformity errors. If some of the pixels of the display are degraded non-uniformly, simply increasing the drive current of the display does not solve the non-uniform degradation problem. Even after increasing the drive current, some pixels will be brighter than other pixels.

[0006] Thus, there is a continuing need for ways of controlling OLED displays that compensate for display aging.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] **FIG. 1** is an enlarged, partial cross-sectional view in accordance with one embodiment of the present invention;

[0008] **FIG. 2** is an enlarged, partial cross-sectional view of another embodiment of the present invention;

[0009] **FIG. 3** is an enlarged, partial cross-sectional view in accordance with still another embodiment of the present invention;

[0010] **FIG. 4** is a block diagram of a system for implementing one embodiment of the present invention; and

[0011] **FIG. 5** is a flow chart for software in accordance with one embodiment of the present invention.

DETAILED DESCRIPTION

[0012] In one embodiment of the present invention, an organic light emitting device (OLED) display may include a pixel formed of three distinct color emitting layers. In this way, colors may be produced by operating more than one stacked subpixel layer to provide a "mixed" color. Alternatively, different subpixel color elements may be spaced from one another to generate three color planes.

[0013] Referring to **FIG. 1**, an OLED display **30** may include a substrate **32**, which in one embodiment may be formed of a glass layer. Light generated by the organic light emitting device **34** exits through the substrate **32** as indicated by the arrows.

[0014] In one embodiment, the organic light emitting device **34** is deposited on the substrate **32** and then covered with a thermal material **40**. In some embodiments, the thermal material **40** may be a thermal epoxy or resin. Advantageously, the material **40** distributes heat generated by the light emitting device **34** for reasons described hereinafter. Alternatively, the layer **40** may include a combination of a passivation material that is moisture impervious that in turn is covered by thermal epoxy. One or more sensors **36** may be distributed along the length of the display **30**. In one embodiment, the sensors **36** may also be deposited on the substrate **32**. The sensors **36** may be thermistors or thermocouples as two examples.

[0015] Because of the thermal conductivity of the thermal material **40**, the sensors **36** may accurately sense the heat generated by the organic light emitting device **34** when appropriate current drive is applied. Row and column electrodes (not shown) may be utilized to apply a suitable drive current to the organic light emitting device **34**.

[0016] The thermal material **40** may be covered by a cover **38**. In one embodiment, the cover **38** may comprise a dessicant, such as calcium oxide (CaO). As a result of the configuration shown in **FIG. 1**, an ongoing reading of the actual temperature of the organic light emitting material **34** forming the pixels of a display **30** is available.

[0017] The lifetime of the organic light emitting display **30** is a function not only of the total integrated charge Q but is also a function of the total effective integrated charge Q_{eff}. The total effective integrated charge may be calculated by including the impact of temperature on the integrated charge during a short time interval dt. In one embodiment, the temperature may be calculated at regular time intervals, dt, that are short relative to the variation in temperature of the display **30**. For example, the temperature may be measured using the sensors **36** at intervals on the order of 1 to 100 seconds.

[0018] The correction for the integrated charge (dQ_{eff}) for the time interval dt may then be calculated by an experimentally determined functional form specific to the particular manufacturing process utilized. For example, the charge correction dQ_{eff} may equal A*dQ*exp(−Ea/kT), where A and Ea are constants that are characteristic of the manufacturing process, dQ is the actual measured integrated charge during the time interval by circuitry external to the organic light emitting material **34**, k is Boltzmann's constant, and T is the absolute temperature in degrees Kelvin. See I. D. Parker et al., J. of Applied Physics, Vol. 85, No. 4, Feb. 15, 1999, pp. 2441-2447.

[0019] The contribution of dQ_{eff} is then added to the previous dQ_{eff} contribution to determine Q_{eff}. Finally, the previously characterized luminance versus current curve associated with that value of Q_{eff} is applicable to compensation.

[0020] Further, the luminance versus current characteristics for the organic light emitting material **34** is temperature dependent. Generally, luminance increases 1% for each 3 degrees Centigrade increase in temperature near zero integrated charge (and sometimes much greater during aging). For a given manufacturing process, the luminance versus current curve for the organic light emitting device **34** is characterized as a function of total integrated charge and temperature. Therefore, the luminance versus current curve is used to determine the current needed to achieve a specified luminance as a function not only of the effective integrated charge, but also temperature.

[0021] Thus, by the incorporation of one or more sensors **36**, as described above, an ongoing reading of temperature may be utilized. The effect of temperature on luminance can be determined so that the operation of the display **30** may be compensated for the effects, not only of total integrated charge, but also of temperature.

[0022] In some embodiments, the sensors **36** may be placed in direct contact with the device **34**. However, in other embodiments, it is sufficient to use a plurality of sensors **36** not in direct contact with an array of light emitting devices **34**. A sensor **36** may be electrically contacted through the substrate **32** in one embodiment. Alternatively, metalizations or other conductive depositions may be utilized to electrically couple the sensor **36**. In still other embodiments, the sensor **36** may be contacted through the thermal material **40** or, if necessary, through the cover **38**.

[0023] Referring to **FIG. 2, a** tiled display **30***a* may include a plurality of tiles, only one of which is shown in **FIG. 2**. In the tiled display **30***a*, each of the tiles making up the overall display **30***a* displays a portion of an overall image. The tiled display **30***a* displays a composite image made up of the contributions of each of the individual tiles.

[0024] Due to the need to substantially seamlessly abut the individual tiles one against the other, there may be no perimeter in which a temperature sensor may be placed. In such case, a back panel **46** may be used to create a closed space in which to receive the organic light emitting device **34**. The device **34** may be formed on contacts (not shown) on the substrate **32**, which may be a transparent glass layer in one embodiment. The organic light emitting device **34** depositions that form each subpixel may be covered by a passivation layer **48**. The passivation layer **48** may be a moisture impervious material. The passivation layer **48** may be covered by a thermal material **40**, such as epoxy or resin, as two examples.

[0025] In one embodiment, the back panel **46** may be a ceramic layer that provides for electrical connections to the individual subpixels formed of the device **34**. For example, a driver circuit **44** may be electrically coupled to the individual device **34** depositions via the back panel **46**.

[0026] In one embodiment, a temperature sensor **36***a* may be inserted in a fill hole **50**. The fill hole **50** may be provided to inject the thermal material **40** in one embodiment. The thermal material **40** transfers the heat from the device **34** depositions to the sensors **36**, which then may be coupled electrically to the integrated circuit **44** in one embodiment.

[0027] In one embodiment, a temperature sensor **47** on the inner surface of back panel **46** may be electrically coupled through vias or fill holes **50**.

[0028] As an alternative embodiment, the sensor **36***a* may be formed on the back panel **46** itself on the surface of the back panel nearest a substrate **32**.

[0029] In some embodiments, the sensor **36***a* may extend downwardly into closer contact or proximity to the material **34** depositions.

[0030] In some embodiments, electrical connections may be made between the back panel **46** and the OLEDs **34** on the substrate **32**. For example, a surface mount technique, not illustrated in **FIG. 2**, may be utilized, wherein solder balls are utilized to electrically couple the driver circuit **44** through fill holes **50** in the back panel **46** to the devices **34**. Again, row and column electrodes may be utilized to contact the device **34**. Those row and column electrodes are not shown. They too may be formed on opposed front and back surfaces of the device **34** and one of the electrodes may be light transmissive.

[0031] With very large displays made up of a large number of display modules a plurality of sensors **36** may be employed to insure sufficiently accurate temperature measurements across the array. For example, there may be one sensor **36** in each display module. Advantageously, sufficient sensors **36***a* are utilized to insure that temperature changes of about 2° Centigrade are measured in one embodiment.

[0032] Referring to **FIG. 3**, in a display **30***b*, the organic light emitting devices **34** emit light upwardly and not through the substrate **32** in one embodiment of the invention. Drive circuitry (not shown) may then be formed in the layer **52** on the substrate **32**. A passivation layer **48** may be provided over the light emitting device **34**. In such case, a sensor **36***b* may be incorporated or integrated with the other electronics in the layer **52**. In one embodiment, the substrate **32** is silicon and the layer **52** and sensor **36***b* are circuitry formed at the top surface of the substrate **32** by integrated circuit processing techniques.

[0033] In another embodiment, the display temperature may be based on previously characterized current-voltage characteristics of the individual subpixels as a function of temperature and integrated charge. This method may be less accurate because of statistical variation in the predicted aging behavior of the display relative to the generally more stable behavior of temperature sensors. However, it does have the advantage of being a direct measurement of temperature and takes into consideration variations at all locations and may avoid the need for temperature sensors.

[0034] Referring to **FIG. 4**, the display may include an electrical system **200** that may be part of a computer system, for example, or part of a stand-alone system. In particular, the electrical system **200** may include a Video Electronic Standard Association (VESA) interface **202** to receive analog signals from a VESA cable **201**. The VESA standard is further described in the Computer Display Timing Specification, V.1, Rev. 0.8 (1995). These analog signals indicate images to be formed on the display and may be generated by a graphics card of a computer, for example. The analog signals are converted into digital signals by an analog-to-digital (A/D) converter **204**, and the digital signals may be stored in a frame buffer **206**. A timing generator **212** and address generator **214** may be coupled to the frame buffer **206** to regulate a frame rate by which images are formed on the screen. A processor **220** may be coupled to the frame buffer **206** via a bus **208**.

[**0035**] The processor **220** may be coupled to a storage device **216**. In one embodiment of the present invention, compensation software **218** may be stored on the storage **216**. The temperature sensors **36** may also be coupled to the processor **220**.

[**0036**] Referring finally to **FIG. 5**, the compensation software **218** may initially capture the temperature information from the sensors **36** at periodic intervals dt, as indicated in block **224**. A correction for the total effective integrated charge may then be calculated as indicated in block **226**. From this information the effective integrated charge Q_{eff} may be calculated as indicated in block **228**. The drive current to the display may then be adjusted according to the correct luminance vs. current curve as indicated in block **230** and the display temperature. Thus, in some embodiments, the temperature effects on luminance may also be compensated on an on-going basis.

[**0037**] While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

What is claimed is:

1. A method of compensating an organic light emitting device display comprising:

measuring a characteristic of the display indicative of temperature; and

adjusting the output light intensity of said display in view of the measured temperature.

2. The method of claim 1 wherein measuring a characteristic of the display includes covering a plurality of organic light emitting elements with a thermally conductive material.

3. The method of claim 2 including placing a temperature sensor in thermal communication with said material.

4. The method of claim 3 including depositing an organic light emitting element on a substrate and forming the temperature sensor on said substrate in thermal contact with said organic light emitting element.

5. The method of claim 1 including forming an organic light emitting element on a substrate, covering said organic light emitting element with a thermally conductive material, covering said thermally conductive material with a cover, and providing an opening in said cover to receive a temperature sensor.

6. The method of claim 5 including passing a temperature sensor through a hole in said cover.

7. The method of claim 6 including providing said temperature sensor in a fill hole for providing filler material to the region between said cover and said substrate.

8. The method of claim 1 including forming an integrated circuit layer on a substrate, forming organic light emitting elements on said integrated circuit layer and forming a temperature sensor in said integrated circuit layer.

9. The method of claim 1 including automatically periodically measuring the temperature of said display.

10. An article comprising a medium storing instructions that enable a processor-based system to:

measure a characteristic of an organic light emitting device display indicative of temperature; and

adjust the output light intensity of said display in view of the measured temperature.

11. The article of claim 10 further storing instructions that enable the processor-based system to automatically periodically measure the temperature of said display.

12. The article of claim 11 further storing instructions that enable the processor-based system to use the measured temperature to calculate the effect of temperature on total effective integrated charge.

13. The article of claim 12 further storing instructions that enable the processor-based system to determine the drive current to said display based on the differential total integrated charge.

14. The method of claim 13 further storing instructions that enable the processor boot system to use the luminance versus current characteristic of a display to adjust the drive current based on the corrected total integrated charge.

15. An organic light emitting device display comprising:

a plurality of organic light emitting elements;

a temperature sensor; and

a controller to periodically and automatically measure the temperature of said elements.

16. The display of claim 15 wherein said temperature sensor is formed within said display.

17. The display of claim 16 including a cover and a substrate with organic light emitting elements formed thereon, said organic light emitting elements enclosed within said cover, and said temperature sensor positioned between said cover and said substrate.

18. The display of claim 15 wherein said sensor is formed on said substrate.

19. The display of claim 17 wherein said cover includes a fill hole and said sensor is positioned in said fill hole.

20. The display of claim 15 including a substrate, said light emitting elements formed on said substrate, said substrate including an integrated circuit layer, said sensor formed in said integrated circuit layer.

21. The display of claim 15 wherein said controller automatically calculates the drive current to compensate said display for the effects of the temperature of said elements.

22. The display of claim 15 wherein said controller uses the luminance versus current curve for the display to determine the appropriate drive current in view of the current temperature of said elements.

* * * * *

patsnap

专利名称(译)	补偿有机发光器件显示器以获得温度效应		
公开(公告)号	US20030048243A1	公开(公告)日	2003-03-13
申请号	US09/951834	申请日	2001-09-11
[标]申请(专利权)人(译)	KWASNICK ROBERT°F		
申请(专利权)人(译)	KWASNICK罗伯特·		
当前申请(专利权)人(译)	英特尔公司		
[标]发明人	KWASNICK ROBERT F		
发明人	KWASNICK, ROBERT F.		
IPC分类号	G09G3/32		
CPC分类号	G09G3/3208 G09G2320/0295 G09G2320/041 G09G2320/043		
其他公开文献	US7446743		
外部链接	Espacenet USPTO		

摘要(译)

可以驱动显示器以补偿显示器上老化的影响。特别地，显示器的温度可以持续确定并用于进一步校正温度效应的总积分电荷。