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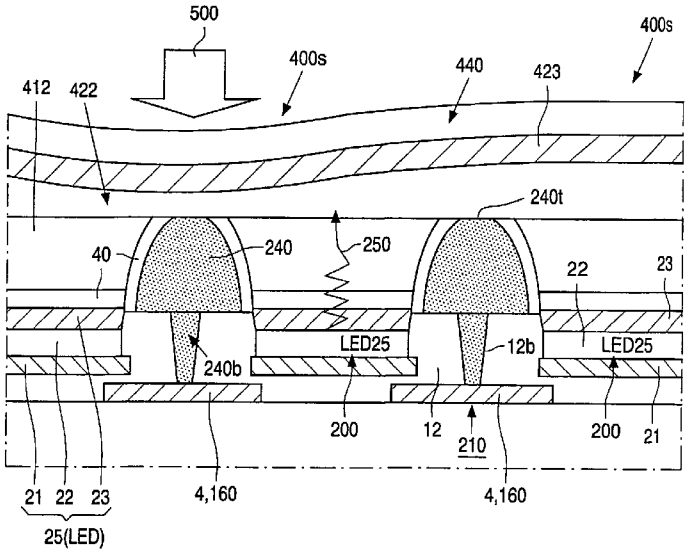
(54) Title: ACTIVE MATRIX ELECTROLUMINESCENT DISPLAY DEVICES, AND THEIR MANUFACTURE



(57) Abstract: Physical barriers (210) are present between neighbouring pixels (200) on a circuit substrate (100) of an active-matrix electroluminescent display device, particularly with LEDs (25) of organic semiconductor materials. The invention forms these barriers (210) with metal or other electrically-conductive material (240) that serves as an interconnection between a first circuit element (21, 4, 5, 6, 140, 150, 160, T1, T2, Tm, Tg, Ch) of the circuit substrate and a second circuit element (400, 400s, 23), for example, a sensor (400s) of a sensor array supported over the pixel array. The conductive barrier material (240) is insulated (40) at the sides of the barriers adjacent to the LEDs and has an un-insulated top connection area (240t) at which the second circuit element is connected to the conductive barrier material (240).

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DESCRIPTION

ACTIVE MATRIX ELECTROLUMINESCENT DISPLAY DEVICES, AND THEIR MANUFACTURE.

This invention relates to active-matrix electroluminescent display devices, particularly but not exclusively using light-emitting diodes of semiconducting conjugated polymer or other organic semiconductor materials. The invention also relates to methods of manufacturing such devices.

Such active-matrix electroluminescent display devices are known, comprising an array of pixels present on a circuit substrate, wherein each pixel comprises an electroluminescent element, typically of organic semiconductor material. The electroluminescent elements are connected to circuitry in the substrate, for example drive circuitry that includes supply lines and matrix addressing circuitry that includes addressing (row) and signal (column) lines. These lines are generally formed by thin-film conductor layers in the substrate. The circuit substrate also includes addressing and drive elements (typically thin-film transistors, hereafter termed "TFT"s) for each pixel.

In many such arrays, physical barriers of insulating material are present between neighbouring pixels in at least one direction of the array. Examples of such barriers are given in published United Kingdom patent application GB-A-2 347 017, published PCT patent application WO-A1-99/43031, published European patent applications EP-A-0 895 219, EP-A-1 096 568, and EP-A-1 102 317, the whole contents of which are hereby incorporated herein as reference material.

Such barriers are sometimes termed "walls", "partitions", "banks", "ribs", "separators", or "dams", for example. As can be seen from the cited references, they may serve several functions. They may be used in manufacture to define electroluminescent layers and/or electrode layers of the individual pixels and/or of columns of pixels. Thus, for example, the barriers prevent pixel overflow of conjugate polymer materials that may be ink-jet

printed for red, green and blue pixels of a colour display or spin-coated for a monochrome display. The barriers in the manufactured device can provide a well-defined optical separation of pixels. They may also carry or comprise conductive material (such as upper electrode material of the electroluminescent element), as auxiliary wiring for reducing the resistance of (and hence the voltage drops across) the common upper electrode of the electroluminescent elements.

It is an aim of the present invention to enhance the capabilities and/or performance of active-matrix electroluminescent display devices, in a manner that is compatible with the basic device structure, its layout and its electronics.

According to one aspect of the present invention, there is provided an active-matrix electroluminescent display device having the features set out in Claim 1.

In accordance with the invention, the physical barriers between pixels are used to provide interconnections between a first circuit element of the circuit substrate and a second circuit element that is connected at the top of the barrier. Thus, these pixel barriers are partly (possibly even predominantly) of electrically-conductive material (typically metal) which provides the interconnection, while also being insulated at least at the sides of the barriers adjacent to the electroluminescent elements.

Much versatility is possible in accordance with the invention. Various layout features can be adopted for the pixel barriers, depending on the circuit elements being interconnected. Thus, the conductive barrier material may provide interconnections that are localised to, for example, individual pixels or groups of pixels, or interconnections that may be located outside the pixel array. Thus, each un-insulated top connection area may itself be localised as part of a connection pattern along the top of the barriers, and/or the interconnecting conductive barrier material may be localised in, for example, separately insulated lengths of the barriers.

The first and second circuit elements may take a variety of forms, depending on the particular improvement or enhancement or adaptation being

made. Typically, the first circuit element of the circuit substrate may be one or more thin-film elements of the group comprising: a conductor layer; an electrode connection; a supply line; an addressing line; a signal line; a thin-film transistor; a thin-film capacitor. The second circuit element may be another such thin-film element in the circuit substrate and/or, for example, an electrode connection of the electroluminescent element of a respective pixel or an added component such as a sensor.

The last possibility permits various forms of sensor array to be integrated together with the array of pixels. The sensor array may be integrated within the circuit substrate. However, the sensor array may be supported on top of the barriers and over the pixel array. This provides a compact layout and is particularly suitable for direct pen input and/or finger-print sensing. The sensor array may even share matrix addressing circuitry of the pixel array in the circuit substrate. This simplifies the integration of the sensor array with the pixel array. Sharing may be achieved in a manner similar to that disclosed in, for example, United States patents US-A-5,386,543 and US-A-5,838,308 (Philips refs: PHB33816 and PHB33715). The whole contents of US-A-5,386,543 and US-A-5,838,308 are hereby incorporated herein as reference material.

As well as using the barriers to provide interconnections in accordance with the present invention, the barriers (or at least other separately insulated lengths of the barriers) may serve different functions. They may be used to form, for example, a component such as a capacitor or inductor or transformer and/or to back-up or replace thin-film conductor lines of the circuit substrate. These back-up or replacement lines may be, for example an address line, a signal line or a supply line.

According to another aspect of the present invention, there are also provided advantageous methods of manufacturing such an active-matrix electroluminescent display device.

Various advantageous features and feature-combinations in accordance with the present invention are set out in the appended Claims.

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