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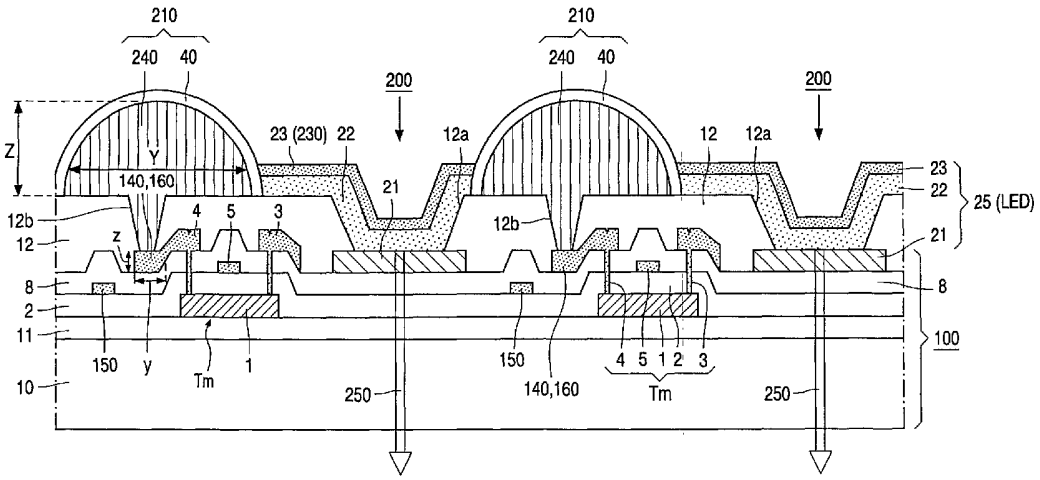
(54) **Title:** ACTIVE MATRIX DISPLAY DEVICES, AND THEIR MANUFACTURE



(57) **Abstract:** Physical barriers (210) are present between neighbouring pixels (200) on a circuit substrate (100) of an active-matrix display device, such as an electroluminescent display formed with LEDs (25) of organic semiconductor materials. The invention forms at least parts of the barriers (210) with metal or other electrically-conductive material (240) that is insulated (40) from the LEDs but connected to the circuitry (4, 5, 6, 9, 140, 150, 160, T1, T2, Tm, Tg, Ch etc.) within the substrate (100). This conductive barrier material (240) may back up or replace, for example, matrix addressing lines (150) and/or form an additional component either within the pixel array or outside. The additional component comprising the conductive barrier material (240) is advantageously a capacitor (Ch), or an inductor (L) or transformer (W), or even an aerial.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DESCRIPTION

ACTIVE MATRIX DISPLAY DEVICES, AND THEIR MANUFACTURE.

This invention relates to active-matrix display devices, particularly but not exclusively electroluminescent displays 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.

Active-matrix liquid-crystal displays (AMLCDs) similarly comprise a circuit substrate on which an array of pixels is present. In the AMLCD case, upstanding spacers (pillars, for example) are present on the circuit substrate between at least some of the neighbouring pixels. These spacers support the overlying opposite plate of the display over the active-matrix circuit substrate to define the cell spacing in which the liquid crystal material is accommodated. For the purpose of the present invention when applied to AMLCDs, the spacers/pillars between pixels of an AMLCD will be compared with the barriers between pixels of an active-matrix electroluminescent display (AMELD) and will be termed "barriers".

It is an aim of the present invention to exploit, develop, adapt and/or extend particular features of active-matrix display devices, so as to permit improvement and/or enhancement of the performance and/or capabilities of the device 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 display device (for example an AMELD or an AMLCD) having the features set out in Claim 1.

In accordance with the invention, the physical barriers between pixels are used to provide connections into and/or out of the circuit substrate, and may provide additional components of the device.

Thus, these pixel barriers are partly (possibly even predominantly) of electrically-conductive material, typically metal. This conductive barrier material is connected with a circuit element within the circuit substrate, while also being insulated at least at the sides of the barriers adjacent to the pixel

display elements. The said circuit element in the circuit substrate may take a variety of forms, depending on the particular improvement or enhancement or adaptation being made. Typically, it 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.

Much versatility is possible in accordance with the invention. Various structural features can be adopted for the pixel barriers. Thus, the conductive barrier material may extend as, for example, a line across the array, or it may be localised to, for example, individual pixels or groups of pixels or to other device areas.

Where the conductive barrier material is used to form an additional component, that component may be formed inside or outside the pixel array. As compared with connecting an external component, the integration of this additional component with pixel barrier technology can be used to enhance device performance at reduced cost and in compact areas within the display device.

At least some lengths of the conductive barrier material may simply serve as a back-up or even as a replacement for at least part of a thin-film conductor line of the circuit substrate, for example an address (row) line, a signal (column) line or a supply line. Thus, the conductive barrier material may provide (or at least back up) the addressing lines (row conductors) over most of their length to reduce voltage drops along the addressing lines. In a case such as this, the barriers may be predominantly of conductive material (typically metal), or they may be predominantly of insulating material with a conductive coating.

Barrier structures used in accordance with the invention may be constructed with a metal core. This metal core can be used in various ways.

The metal core may itself provide the conductive barrier material that is connected with the circuit element in the substrate. It may have an insulating coating on at least its sides.

A metal coating can be provided on an insulating coating on the metal core. This metal coating may be connected to another circuit element. In one

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