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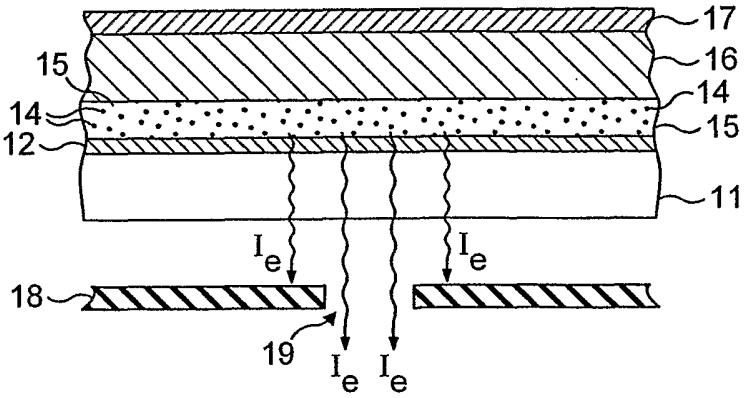

(57) Abstract: Certain materials are electroluminescent, and this electroluminescent effect has been used in the construction of backlights for displays. Such a backlight commonly consists of a transparent front layer (11) known as the substrate carrying over its rear face a transparent electrically-conductive film (12) forming the backlight's front electrode and covered by a layer of electroluminescent/phosphor material (13) over the rear face of which is a high-dielectric layer (16) bearing on its rear face a conductive film (17) forming the back electrode. The whole is positioned behind a mask (18) that defines whatever characters the display is to show. This use of a mask has some disadvantages, some of which can be overcome by utilising an array of suitably shaped individual electrodes (21) instead of a continuous one; however, this itself has drawbacks, since the lead (22) to each electrode acts as an electrode in its own right, activating the phosphor to show faint but distracting additional illumination. The invention deals with this problem of track-derived tails; it proposes firstly that the electroluminescent material itself be shaped into discrete areas (43) each tightly matching in shape and size the relevant individual shaped back electrode (21), and secondly (or in addition) that there be used a shield layer (71) of electrically-conductive material shaped and sized as a negative of the shaped area back electrode (21) and positioned as an intermediate electrode between and aligned with the shaped area electrode (21) and the electroluminescent material layer (43), and given the same electrical potential as the front electrode (12).

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Electroluminescent displays

This invention is concerned with electroluminescent displays, and relates in particular to improving the uniformity and visibility of such displays.

Certain materials are electroluminescent - that is, they emit light, and so glow, when an electric field is generated across them. The first known electroluminescent materials were inorganic particulate substances such as zinc sulphide, while more recently-found electroluminescent materials include a number of small-molecule organic emitters known as organic LEDs (OLEDs) and some plastics - synthetic organic polymeric substances - known as light-emitting polymers (LEPs). Inorganic particulates, in a doped and encapsulated form, are still in use, particularly when mixed into a binder and applied to a substrate surface as a relatively thick layer; LEPs can be used both as particulate materials in a binder matrix or, with some advantages, on their own as a relatively thin continuous film.

This electroluminescent effect has been used in the construction of displays, in which a large area of an electroluminescent material - generally referred to in this context as a phosphor - is provided to form a backlight which can be seen through a mask that defines whatever characters the display is to show.

Such a backlight commonly consists of, from front (the side from which it is to be viewed) to back:

a relatively thick protective electrically-insulating transparent front layer known as the substrate and made usually of a glass or a plastic such as polyethylene terephthalate (PET);

over the entire rear face of the substrate, a very thin transparent electrically-conductive film made from a material such as indium tin oxide (ITO), this forming one electrode - the front electrode - of the backlight;

covering the rear face of the front electrode, a relatively thin layer of electroluminescent/phosphor material (usually a particulate phosphor within a binder matrix);

over the rear face of the phosphor layer, a relatively thin electrically-insulating layer of a material - usually a ceramic - having a relatively high dielectric constant (relative permittivity) of around 50;

covering the entire rear face of the electrically-insulating layer, a continuous electrically-conductive film, usually opaque (and typically carbon or silver), forming the other electrode - the back electrode - of the backlight.

In addition, the back electrode layer, which is quite delicate, is covered with a protective film (usually another, similar, ceramic layer) to prevent the layer being damaged by contact with whatever device components - electronic circuitry, for example - might be mounted behind the display.

Each of the various layers is conveniently screen-printed into place (apart from the ITO front electrode, which is usually sputtered onto the substrate) in the normal way, through masks that define the shape, size and position of the layer components, using suitable pastes that are subsequently dried, set or cured, commonly by heat or ultraviolet light, as appropriate, prior to the next layer being applied. And in the context of electroluminescent displays, the expressions "relatively thick" and "relatively thin" mean thicknesses in the ranges, respectively, of 30 to 300

micrometres, usually around 100 micrometres, and less that 50 micrometres, and most usually 25 micrometres or less.

In a display, such a backlight is positioned behind a mask that defines whatever characters the display is to show. Unfortunately, to form a truly effective, easy-to-read display the background uniformity of the display must be well controlled so as not to distract the eye of the Viewer from the information that it is intended to reveal. To date this has not satisfactorily been achieved for electroluminescent displays.

As intimated above, the majority of electroluminescent displays exploit the uniform illumination properties of the electroluminescent principle as a backlight, enabling graphics characters to be formed through the use of cut out overlays that allow the light to shine through specific apertures. Characters formed in this way using particulate phosphors tend to be less than sharp. Moreover, such a display is an "all or nothing" display; when the backlight is "on", all the characters are illuminated, while when it is "off" none of them are.

It was then realised, however, that much clearer, crisper displays, with individually-activatable characters, could be constructed by "reversing" the normal structure of backlight with masking overlays. More specifically, it was found that if the phosphor layer were associated on at least one side (and particularly at the rear) with an array of individual appropriately-shaped electrodes instead of a continuous electrode then the mask could be done away with completely, for the phosphor could be inherently activatable in the forms of the discrete shapes desired - for example, an ikon, an alphanumeric character, or a pattern of independently-switchable segments that by their arrangement provide

reconfigurable information - so there could be made a display that had the desired sharpness.

The thus-formed displays were indeed a considerable advantage over the previous, mask-utilising, ones, but they still suffered from a number of drawbacks. One such arose directly from the use of individual appropriately-shaped back electrodes instead of a continuous electrode; whereas with a continuous back electrode extending effectively from edge to edge of the display an activating voltage could be supplied by a lead to a contact at the very edge of the display, which could easily be hidden from sight, individual back electrodes required leads, formed as conductive tracks laid onto the dielectric layer carrying the electrodes, some of which track leads necessarily crossed over the main area of the display. And since each track lead, even though extremely narrow, acted as an electrode in its own right, the phosphor was activated not only by each individual shaped electrode but also by the lead to that electrode, giving rise to a faint, but distracting (and possibly confusing), additional source of illumination, making each ikon or character of the display look as though it had a tail.

Various attempts have been made to deal with this problem, and one of the more successful to date is not to form the lead tracks directly on the dielectric layer carrying the back electrodes, as is usual, but instead to space the tracks further from the electroluminescent material layer by placing an additional insulating layer, between the tracks and the dielectric layer carrying the electrodes, so as to reduce the field produced by the tracks, and so minimize the unwanted activation and illumination effect of the underlying phosphor. However, each track lead still acts as an electrode, and so still gives rise to a faint, albeit now much fainter, source

of illumination, so that each ikon or character of the display still looks as though it has a tail.

This problem of track-derived tails is one of the problems that the present invention seeks to deal with - and here it proposes to do so in either of two ways. In one, it suggests forming the electroluminescent material itself into discrete areas each tightly matching in shape and size the relevant individual shaped back electrode, while in the other it suggests placing between an electroluminescent material layer (even a continuous such layer) and the shaped back electrodes a shield - a conductive layer - that matches in shape and size a negative of the several shaped areas of the electrodes and so will in use block the field generated across the front and back electrodes everywhere except in the areas matching the shaped electrode areas. With hindsight these simple changes and especially that of shaping the electroluminescent material to match the shaped electrode areas - may seem somewhat obvious, but it must be pointed out that, in the many years since electroluminescent displays have been in use, no-one has suggested doing either.

In a first aspect, therefore, the invention provides an electroluminescent display of the type wherein a layer of electroluminescent material is sandwiched between but spaced from two electrode layers, which display has a plurality of separately-activatable individual areas each of electroluminescent (phosphor) material, in which display:

both the back electrode layer and also the electroluminescent material layer are each composed of a plurality of separate areas each matching in shape and size the image which the relevant portion of the display is to show.

In a second aspect, moreover, the invention provides an electroluminescent display of the type wherein a layer of electroluminescent material is sandwiched between but spaced from two electrode layers, which display has a plurality of separately-activatable individual areas each of electroluminescent (phosphor) material, in which display:

the back electrode layer is composed of a plurality of separate areas each matching in shape and size the image which the relevant portion of the display is to show;

a shield layer of electrically-conductive material shaped and sized as a negative of the shaped area back electrode is positioned as an intermediate electrode between and aligned with the shaped area electrode and the electroluminescent material layer; and

means are provided enabling the shield layer intermediate electrode to be given the same electrical potential as the front electrode.

In the display of the invention the images to be displayed are in use crisply defined by the combination of shaped back electrode and either shaped phosphor or negatively-shaped shield layer intermediate electrode. Unlike those displays known hitherto, therefore, that of the invention does not need an image-defining mask.

The invention provides an electroluminescent display for some sort of device. This device can be of any shape and form, and for any purpose. A typical example of such a device is a hand-holdable controller - a remote control - for a radio, an audio cassette tape deck, a CD player, a television, a DVD player or a video recorder, and for such a use the device will normally have an oblong panel, perhaps 13x5cm (5x2in), on which are positioned a plurality of individual

display elements appropriate to the device's purpose. Thus, for instance, for a tape deck the display elements might be ikons (or words, or the individual letters of words) that represent (amongst other possibilities) "play", "fast forward", "fast reverse", "record", and "stop".

The display of the invention is an electroluminescent display - that is, it is a display which uses electroluminescence to light up its several parts. More specifically, it is such a display utilising layers of a particulate electroluminescent material - a particulate phosphor - rather than continuous sheets or films of electroluminescent material. The particulate phosphor can be a light-emitting plastic (LEP) in particulate form, but most preferably it is an inorganic material; a typical inorganic particulate phosphor is zinc sulphide, especially in the form of encapsulated particles (encapsulation provides substantially-increased stability and life). An especially convenient such zinc sulphide is that heat-curable material available under the name 7151j Green Blue from Dupont, in a layer around 25 micrometer thick. Another such sulphide is 8164 High Bright Green, also from DuPont.

Unlike many electroluminescent displays known in the art, the invention's display has, instead of a single large area of uniformly-activatable electroluminescent material forming a "back light" to the mask-defined characters or ikons to be displayed, separately-activatable individual areas each of which represents either a whole or a part of a character or ikon to be displayed. As a result, the display appears much sharper, crisper and "cleaner" than the conventional back-panel versions.

In this display each character or ikon can be whole and complete in itself - an individual number or letter (of the alphabet), or an ikon (or symbol,

pictogram, cartouche or glyph) representing some desired effect (such as the right-pointing single chevron commonly employed to mean "play", or the similar double chevron meaning "fast forward"). However, in addition - or as an alternative - the individual areas can form small parts of a larger region which itself has some meaning or message. Thus, the small individual areas can be grouped into sets of related character-defining segments each group of which can, by the activation of the appropriate segments, define any character there to be displayed. A typical group is the standard seven-segment group commonly employed in modern electrical and electronic displays; by suitably choosing which of the segments is switched on, so the group can be made to display any Arabic numeral or Roman-alphabet character (other numbering or alphabet systems may need groups with more segments). The groups themselves can of course be disposed in an array; by manipulating each of the portions of the array so there may be presented, for example, a complete textual message.

Each activatable area comprises a thin (around 25 micrometre) layer of phosphor having on either side - adjacent each face of the layer - the (front or rear) electrode which is used to provide the voltage across the layer to switch it into its electroluminescent state. More specifically, in the first aspect of the invention - that aspect using shaped phosphor areas - that back electrode and also the electroluminescent material are each composed of a plurality of separate areas each matching in shape and size the image which the relevant portion of the display is to show. The thus-shaped back electrode is accordingly patterned, to form an array of separate appropriate tightly-defined outline shapes at the resolution of the information or information segments to be displayed, and each shape of this array is addressable (supplied

with the driving voltage) independently of all the others.

In addition, in this first aspect the electroluminescent layer - the phosphor - is itself patterned with an appropriate array of tightly-defined outline shapes at the resolution of the information or information segments to be displayed.

As in the art, the phosphor layer is covered with an insulating layer, usually of ceramic material. A typical such material is DuPont's heat-curable 7153e, or their UV-curable 5018 ceramic, in a layer around 10 to 15 micrometre thick. The back electrodes are then formed on this insulating layer, usually utilising a silver paste such as Norcote's UV-curable ELG110 to lay down a relatively thin layer - around 20 micrometre - where required.

The rear face of the display may then be protected with a thin - 15 micrometre - ceramic insulating layer (typically using DuPont's 5018, as above, though another possibility is Coates' UV600G).

By the shaped electrode/phosphor arrangement of the invention - both the back electrode and also the phosphor itself being composed of a plurality of separate areas each matching the image to be shown - so there is formed a display wherein, at least in principle, there can, in use be seen only the desired images, without any sign of "tails" caused by the electrodes' lead tracks. However, in practice it may be that the two arrays of shapes - in the chosen electrode and in the phosphor - are not perfectly aligned, with the result that some very short portion of an electrode's lead track may in fact overlap, and so activate, the corresponding phosphor shape.

This out-of-registration problem can satisfactorily be dealt with in a number of ways. One - as already proposed - is to space the lead tracks further from the phosphor than their electrodes, so

that the tracks necessarily have a less "activating" effect. If the spacing is sufficient then the activation of the phosphor by the tracks will be insignificant compared to that of the electrodes, and so will not be a distraction. Thus, if the chosen electrode array is the back electrodes, they are first formed without tracks, the spaces in between are then coated with an additional layer of an insulating material (typically a ceramic such as that already used between the back electrodes and the phosphor), and then the tracks are formed (with the same sort of silver paste) over the top of the insulating layer, so that the tracks are spaced further from the phosphor than the back electrodes, and thus their effect is suppressed.

An alternative solution, when using patterned back electrodes, is to shield the phosphor from the effect of the voltage in the tracks themselves by placing a suitably-patterned (track-like) third electrode between the phosphor and the lead tracks, and then applying to that third electrode the same voltage as applied to the front electrode. This third, or intermediate, track-like electrode - which is conveniently positioned adjacent but insulated from the back electrode tracks, and between them and the conventional insulating layer covering the phosphor layer, and made of the same sort of cured silver paste - is patterned to match the pattern of tracks to the various back electrode parts, and the result is that in use any voltage field the tracks generate is blocked, thus suppressing activation of any phosphor layer thereunder.

In the second aspect of the invention each activatable area comprises, as before, a layer of phosphor having on either side - adjacent each face of the layer - the (front or rear) electrode which is used to provide the voltage across the layer to switch

it into its electroluminescent state. And as before the back electrode is patterned - composed of a plurality of separate areas each matching in shape and size the image which the relevant portion of the display is to show. In addition, however, in this second aspect a negatively-patterned shield layer is positioned as an intermediate electrode between and aligned with the shaped area electrode and the electroluminescent material layer, and there are means enabling this shield layer intermediate electrode to be maintained at the same electrical potential as the front electrode.

There is not much that need be said about this intermediate electrode layer - which acts as a mask for the shaped-area back electrode - save that it can be formed of any suitable electrically-conductive material (typically silver), and that it can be applied by screen printing an appropriate silver-loaded paste - typically that mentioned above - onto the phosphor in the normal way. Of course, the corresponding, but "positive", back electrode must then be applied in register with the intermediate layer, but that needs no comment here.

The means enabling this shield layer intermediate electrode to be maintained at the same electrical potential as the front electrode is usually little more than a simple electrical connection between the two, either internally of or external to the display.

It should be noted that in accordance with the second aspect of the invention - using an aligned intermediate-electrode electrically-conductive shield layer formed as a negative of the back electrode shaped area pattern - the electroluminescent material (phosphor) layer can be continuous, for the required shaping of the image is effected by the combination of the patterned back electrode and the negatively-patterned shield. However, it is still possible also

to shape the phosphor layer itself into a plurality of image-defining areas, if that be thought beneficial.

In the invention either both the back electrode layer and the electroluminescent layer - the phosphor - itself are patterned with matching appropriate arrays of tightly-defined outline shapes at the resolution of the information or information segments to be displayed, or the back electrode is so patterned and in addition there is utilised an aligned intermediate-electrode electrically-conductive shield layer formed as a negative of the same pattern and in use having the electrical potential of the front electrode.

By these arrangements, there is formed a display wherein, at least in principle, there can, in use be seen only the desired images, without any sign of "tails" caused by the electrodes' lead tracks.

The various layers of material from which the display of the invention is constructed can be formed by the usual screen printing methods, utilising the various techniques and paste-like materials generally known for that purpose, and no more need be said about that here.

Finally, in addition, the substrate may be overlaid with an exterior protective film, which can if appropriate be coloured or bear legends of one sort or another.

Various embodiments of the invention are now described, though by way of illustration only, with reference to the accompanying diagrammatic Drawings in which:

Figure 1 shows in section a portion of a simplified Prior Art electroluminescent display;

Figure 2 shows in section a portion of an improved, patterned back electrode, version of the Figure 1 simplified Prior Art display;

Figure 3 shows in section a portion of a further improved, spaced track, version of the Figure 2 simplified Prior Art display;

Figure 4 shows in section a portion of a simplified display similar to that of Figure 2 but further improved - having a patterned phosphor layer - in accordance with the invention;

Figure 5 shows in section a portion of an improved simplified display similar to that of Figure 4 but further improved in the spaced-track manner shown in Figure 3;

Figure 5A shows in section a portion of an improved simplified display similar to that of Figure 5 but further improved to facilitate its construction;

Figure 6 shows in section a portion of an improved simplified display similar to that of Figure 5 but further improved by the inclusion of a track-pattern shield;

Figure 7 shows in section a portion of an improved simplified display similar to that of Figure 3 but further improved by the inclusion of a negative-electrode-pattern shield;

Figure 1 shows in section a portion of a simplified Prior Art electroluminescent display. The display is built up on a transparent protective substrate 11 carrying the thin front electrode 12 on which is formed the thicker electroluminescent material (phosphor) layer 13. This phosphor is a granular, particulate, material (as 14) held within a binding matrix 15; the layer itself, however, is here shown as a continuous layer, extending over the entire area of the display.

Behind the phosphor layer 13 - on top, as viewed - is a thick layer of an insulating ceramic layer 16, and on that has been formed the back electrode 17. This back electrode is a continuous one, extending,

like the phosphor layer 13, over the entire area of the display.

In use an opaque mask 18 is positioned in front of the display - below it, as viewed. By the shaped apertures (as 19) this mask defines the "images" that the display is to show, the light I_e emitted by the phosphor being allowed through each aperture 19 but being blocked everywhere else.

Figure 2 shows in section a similar display portion, with substrate 11, transparent front electrode 12, continuous phosphor layer 13, and ceramic insulator layer 14, but has an image-defining back electrode made up of a number of shaped areas (as 21: only one is here shown) each addressable via thin and narrow lead tracks (as 22). Using a shaped, patterned back electrode 21 means notionally that only those areas (as A) of phosphor directly between the individual shapes 21 and the front electrode 11 are activated, providing illumination I_e. In practice, however, the individual lead tracks 22 also act as back electrodes, so that some small amount of illumination i_e is also output from the phosphor layer under them, making the display seem confusing. This problem can be at least partly dealt with in the manner shown in Figure 3, which shows a "spaced-track" version of the Figure 2 display. As can be seen from Figure 3, the shaped areas 21 of the back electrode have been surrounded by a thick layer 31 of insulating material, and then the lead tracks 32 to the electrode areas 21 have been formed on top of that. It will be evident that the tracks 32 are spaced considerably further from the phosphor layer 13 in the Figure 3 embodiment than are the similar tracks 22 in the Figure 2 embodiment, so that the effect the tracks 32 have is concomitantly smaller, and thus the amount of light i_e that they cause to be emitted is also

concomitantly smaller, possibly even to the extent of being negligible.

According to the invention, an improved arrangement for avoiding lead track effects is shown in Figure 4. This shows in section a portion of a simplified display similar to that of Figure 2 but further improved by being made with a patterned phosphor layer made up of separate individual shapes 43 of phosphor material 43. As will be readily apparent, upon activation the emitted light can only come from the shaped phosphor portions, so there can - in principle - be none emitted because of the field generated by the lead tracks 22. However, in practice it may be that the phosphor and back electrode layers 43 and 21 are not exactly in register with each other, so that some short track portion might overlay a part of the relevant phosphor shape 43, and therefore to minimize any resulting effect of the tracks they are best constructed in the "raised" manner shown in Figure 3 - and this is shown in Figure 5.

Figure 5A shows in section a portion of an improved simplified display similar to that of Figure 5 but further improved to facilitate its construction. More specifically, after the insulator layer 14 is formed there is printed into place an additional insulator layer 54, this being a "negative" image of the back electrode layout so that it has apertures 55 that effectively define the back electrode shaped areas. Then, when these areas are completed the electrode material may be laid down in areas that are each slightly larger than the specific shapes desired, so that each electrode 51 overlaps by a small amount the apertures 55 in the insulator layer 54.

Figure 5A also shows the formation of a final, exterior, ceramic insulator layer 56, which provides protection for the previous layers.

Even the Figure 5 version may still show some signs of the unwanted track effect, and therefore in the yet further improved version of Figure 6 there is shown in section a portion of a display similar to that of Figure 5 but including between the tracks 32 and the ceramic insulator layer 14 covering the phosphor layer shapes 43, and embedded in the track-raising insulator layer 31, a conductive track-pattern shield 61. In use this shield is made an intermediate electrode, connected to the front electrode 11 (by means not shown here) so as to be at the same operating potential thereas. By so doing the shield prevents any deleterious - light-generating - effect of the tracks 32.

In Figure 4 there is shown the concept of forming the phosphor layer in appropriately-shaped areas so as to provide the required image. Figure 7 relates to the heretofore described alternative method of achieving this end by the inclusion of a negative-electrode-pattern shield. The display shown is like that of Figure 3, but includes, between the ceramic insulator layer 14 and the phosphor layer 13, an apertured conductive layer 71 the aperture 72 of which (here filled with ceramic insulator material 14) defines, like the shaped electrode area 21, the image to be generated. In use the apertured conductive layer 71 forms an intermediate electrode, electrically connected to the front electrode so as to be at the same potential thereas, and thus - as will be apparent - it completely blocks the effect on the phosphor 13 - here shown as a continuous layer - of the back electrode 21 and its lead track 32, so that only in the area of phosphor defined by the back electrode/intermediate electrode aperture is the phosphor activated and light emitted.

Claims

1. An electroluminescent display of the type wherein a layer of electroluminescent material is sandwiched between but spaced from two electrode layers, which display has a plurality of separately-activatable individual areas each of electroluminescent material, in which display:

both the back electrode layer and also the electroluminescent material layer are each composed of a plurality of separate areas each matching in shape and size the image which the relevant portion of the display is to show.

2. An electroluminescent display as claimed in claim 1, which uses as the electroluminescent material, a particulate phosphor.

3. An electroluminescent display as claimed in claim 2, wherein the particulate phosphor is zinc sulphide in the from of encapsulated particles.

4. An electroluminescent display as claimed in any of the preceding claims, wherein the separately-activatable individual areas are grouped into sets of related character-defining segments each group of which can, by the activation of the appropriate segments, define any character there to be displayed.

5. An electroluminescent display as claimed in claim 4, wherein each group is the standard seven-segment group commonly employed in modern electrical and electronic displays.

6. An electroluminescent display of the type wherein a layer of electroluminescent material is sandwiched between but spaced from two electrode layers, which

display has a plurality of separately-activatable individual areas each of electroluminescent (phosphor) material, in which display:

the back electrode layer is composed of a plurality of separate areas each matching in shape and size the image which the relevant portion of the display is to show;

a shield layer of electrically-conductive material shaped and sized as a negative of the shaped area back electrode is positioned as an intermediate electrode between and aligned with the shaped area electrode and the electroluminescent material layer; and

means are provided enabling the shield layer intermediate electrode to be given the same electrical potential as the front electrode.

7. An electroluminescent display as claimed in claim 6, which uses as the electroluminescent material, a particulate phosphor.

8. An electroluminescent display as claimed in claim 7, wherein the particulate phosphor is zinc sulphide in the from of encapsulated particles.

9. An electroluminescent display as claimed in any of claims 6 to 8, wherein the separately-activatable individual areas are grouped into sets of related character-defining segments each group of which can, by the activation of the appropriate segments, define any character there to be displayed.

10. An electroluminescent display as claimed in claim 9, wherein each group is the standard seven-segment group commonly employed in modern electrical and electronic displays.

11. An electroluminescent display as claimed in any of claims 6 to 10, wherein the means enabling the shield layer intermediate electrode to be maintained at the same electrical potential as the front electrode is a simple electrical connection between the two.

12. An electroluminescent display as claimed in any of claims 6 to 11 which is also a display as claimed in any of claims 1 to 5, and thus wherein the electroluminescent material (phosphor) layer is shaped into a plurality of image-defining areas.

13. An electroluminescent display susbstantially as hereinbefore described, with reference to Figures 4 to 6.

14. An electroluminescent display susbstantially as hereinbefore described, with reference to Figure 7.

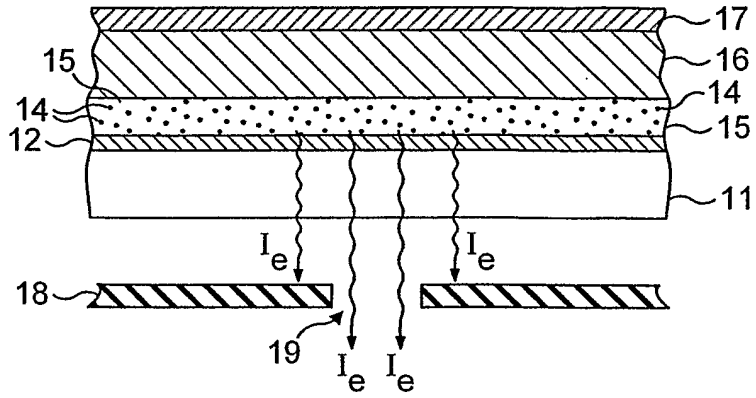

FIG. 1

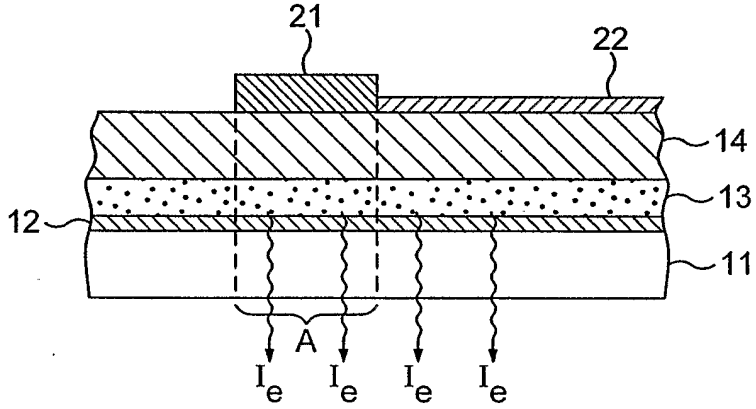

FIG. 2

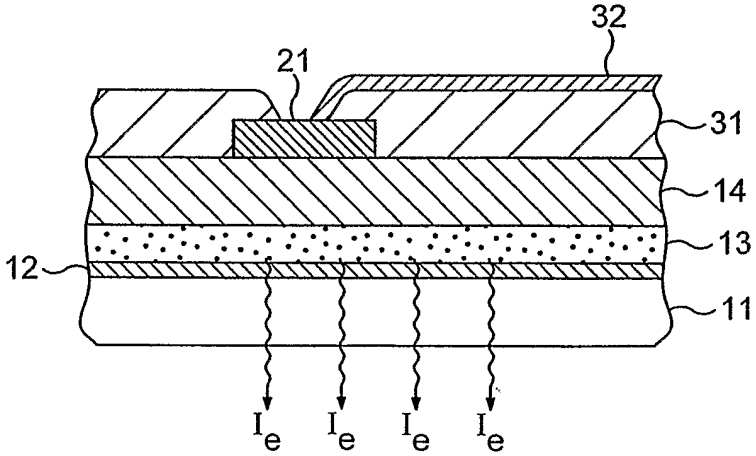

FIG. 3

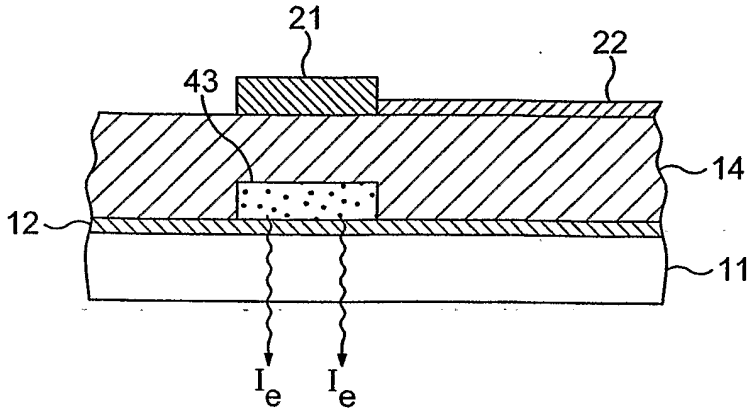

FIG. 4

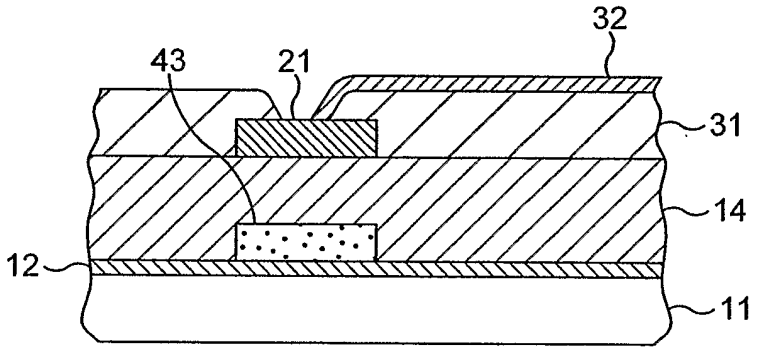

FIG. 5

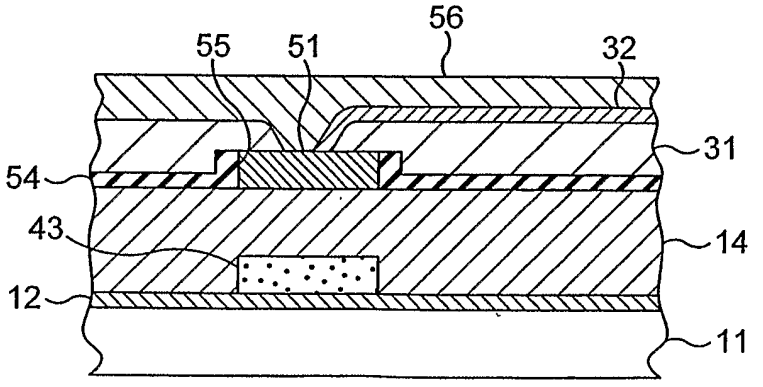

FIG. 5A

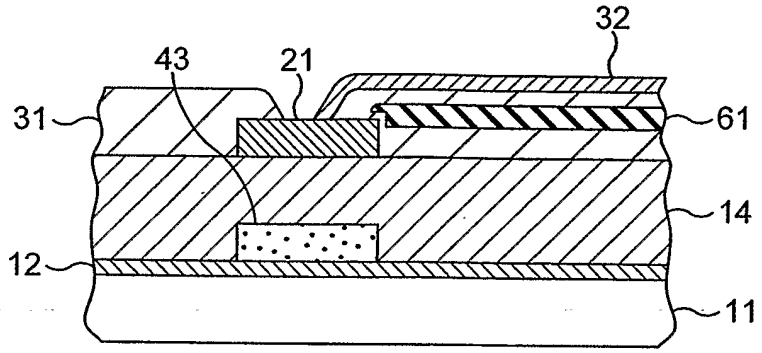

FIG. 6

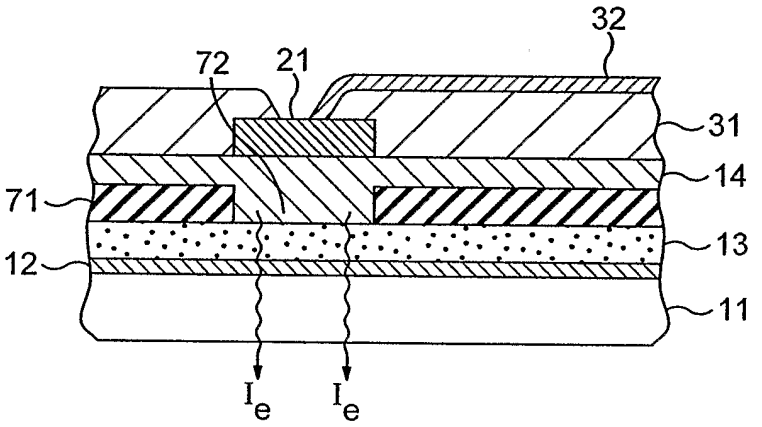

FIG. 7