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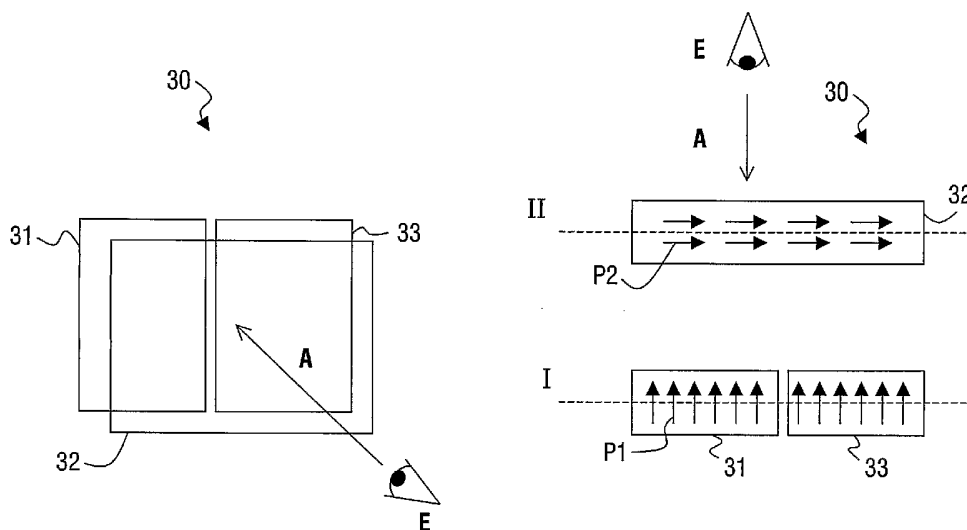
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(54) Title: PIXEL ARRANGEMENT FOR AN EMISSIVE DEVICE



(57) Abstract: The invention relates to a pixel arrangement (20;30) for an emissive device with at least a first emissive pixel and a second emissive pixel, said first emissive pixel and said second emissive pixel having respectively a first emissive area (21;31) and a second emissive area (22;32) adapted to emit light upon excitation. The first emissive area (21;31) is located in a first plane (I) and said second emissive area (22;32) being located in a second plane (II) such that said first emissive area (21;31) and said second emissive area (22;32) at least partially overlap in a viewing direction (A) normal to at least one of said planes (1,11). The first emissive area (21;31) is adapted to emit light with a first polarization direction (P1) and said second emissive area (22;32) is adapted to emit light with a second polarization direction (P2) oriented substantially perpendicular to said first polarization direction (P1). The invention further relates to a display panel and a light source comprising a plurality of such pixel arrangements (20;30).



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Pixel arrangement for an emissive device

The invention relates to a pixel arrangement for an emissive device of at least a first emissive pixel and a second emissive pixel, said first emissive pixel and said second emissive pixel respectively having a first emissive area and a second emissive area adapted to emit light upon excitation, said first emissive area being located in a first plane and said
5 second emissive area being located in a second plane such that said first emissive area and said second emissive area at least partially overlap in a viewing direction normal to at least one of said planes. The pixel arrangement can be employed both in display panels and in light sources.

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In conventional emissive colour display panels, the red (R), green (G) and blue (B) display pixels are arranged adjacent to each other in a single plane of a display panel. This is necessary as most display pixels are non-transparent for visible light. Adjacent positioning of the coloured display pixels however implies that for a fully red light emitting
15 display panel only a third of the emissive area of the display panel contributes to the light emission.

US 5,821,690 discloses an electroluminescent device comprising a first emitter with an organic layer selected so that radiation of a first wavelength is emitted when charge carriers of opposite types are injected into the first emitter and

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first electrode means arranged to inject charge carriers into said first emitter, said first electrode means including first and second contact layers of different types arranged on either side of the first emitter and connected to a source for applying an electric field between the first and second contact layers so that charge carriers of respective first and second types are injected into the first emitter. The device further includes a second emitter
25 comprising an organic layer arranged in viewing overlap with said first emitter and selected so that radiation of a second wavelength is emitted when charge carriers of opposite types are injected into the second emitter and

second electrode means arranged to inject charge carriers into said second emitter, said second electrode means being operable independently of said first electrode

means whereby either radiation of said first wavelength or radiation of said second wavelength or both can be caused to be emitted and viewed.

A disadvantage of such a device is that the materials used for the first and second emitters should be carefully selected with respect to their emission bands and
5 absorption bands to allow such an overlapping arrangement of the emitters.

It is an object of the invention to provide a pixel arrangement with overlapping pixels to enhance the brightness of the brightness with less severe requirements to the
10 emissive materials employed.

This object is achieved by providing a pixel arrangement wherein said first emissive area is adapted to emit light with a first polarization direction and said second emissive area is adapted to emit light with a second polarization direction oriented substantially perpendicular to said first polarization. By having the polarisation directions of
15 both emissive areas perpendicular to each other, light emitted from the lower emissive area will not be blocked or influenced by the upper emissive area, independent of the material used for this upper emissive area. In the present description the term "overlap" and its conjugations should be understood as that the areas in the viewing direction appear to coincide for at least a part of their individual areas. It is noted that the areas may be spatially
20 separated in the viewing direction while overlapping. The first and second emissive pixels may be display pixels or pixels for a light source. The space between the areas may be filled by other layers for the display pixel, such as electrode layers for addressing the display pixels. These layers should be chosen or manipulated such that they are transparent in the relevant wavelength range. In a preferred embodiment such a layer is a colour filter layer.
25 Further it should be appreciated that the display pixel arrangement can be applied for a display panel as well as for a light source.

In an embodiment of the invention the pixel arrangement comprises a third emissive area in a third plane, said third emissive area at least partially overlapping at least one of said first emissive area and said second emissive area in said viewing direction and
30 being optically transparent for light emitted from at least one of said first emissive area and said second emissive area. This third emissive area may complete the display pixel arrangement for provision of the three basic colours R,G and B. If the third plane is the upper plane with respect to viewing direction the third emissive area has an absorption band outside the emission bands of the first or second emissive area. Preferably, the third emissive area

has a third polarisation direction parallel to either said first polarisation direction or said second polarisation direction and is optically transparent for light emitted from respectively said first emissive area or said second emissive area. In this way a colour display pixel arrangement can be achieved comprising the basic colours R, G and B, wherein only for the upper emissive area the choice of emissive materials is limited by considerations regarding the emission- and absorption bands, determined by either the first or the second emissive area.

In an embodiment of the invention, the second emissive area is larger than said first emissive area. Such a larger area enables the use of light emissive materials with a low contribution to the light emission, such as nanowires. Alternatively the larger area may be used for light emitting substances that show fast degradation, such as blue light emitting organic materials. As a result the current per unit area for blue light emissive areas can be reduced, resulting in a considerable increase in the life time. The pixel arrangement may further comprise at least a third emissive area in said first plane or a further plane, overlapped by at least said second emissive area and having a third polarisation direction parallel to said first polarisation. Such an arrangement may provide the basic colours R, G and B, wherein the first and third emissive area are employed to emit the red and green light, whereas the second, larger, emissive area is adapted to emit the blue light. It should be appreciated that other basic or primary colours than R, G and B are possible and more than three emissive areas can be employed.

In an embodiment of the invention the emissive areas may comprises organic light emitting substances, such as light emitting polymeric materials (PLED) and/or light emitting small molecule materials (SMOLED) and/or materials used in light emitting electrochemical cells (LEEC), wherein the organic material is blended with other materials to provide a greater freedom of choice regarding the materials for electrodes attached to it. The emissive areas may also comprise light emissive nano-crystals, such as particular nanotubes or nanowires, or light emitting organic materials in a crystalline state. Nanocrystals are known to emit light upon excitation, which is usually polarized with respect to an anisotropy axis of the nanocrystals. Further aligned arrays of these nano-emitters are transparent for light with a polarisation direction perpendicular to the anisotropy axis. It should be appreciated that the emissive areas of a single display pixel arrangement may comprise different materials, such as a first and third emissive planes of PLED-material and a second emissive area of nanowires.

In an embodiment of the invention the first and second emissive areas are adapted to emit different colours. Together with a third emissive area the panel arrangement may be used for a colour display panel with improved brightness and enhanced freedom of choice in the materials employed for the display pixels.

5 The invention also relates to a display panel comprising a plurality of pixel arrangements as described above, with said emissive pixels as display pixels that are individually addressable and wherein the display panel further comprises means to have at least one of said first and second emissive area emit light in accordance with a data signal for said display panel. In order to emit light, excitation of the emissive areas is achieved by either
10 the application of electricity or by photoluminescence provided by the display panel device. The display pixel arrangement allows a higher brightness for the display panel according to the invention or a lower power consumption, important for mobile application, and/or a less strict excitation efficiency to obtain a brightness comparable to a conventional display panel.

 It should be appreciated that the display panel may constitute either a part of
15 an electric device product or an electric device product as such. Such an electric device product may e.g. relate to handheld devices such as a mobile phone, a Personal Digital Assistant (PDA) or a portable computer as well as to devices such as a monitor for a Personal Computer, a television set or a display on e.g. a dashboard of a car.

 The invention finally relates to a light source comprising a plurality of pixel
20 arrangements as described above and a source to provide power to said pixel arrangements. Such a light source is especially advantageous for sources with a large area emitting surface.

 The invention will be further illustrated with reference to the attached drawings, which show preferred embodiments according to the invention. It will be understood that the invention is not in any way restricted to these specific and preferred
25 embodiments.

In the drawings:

 Fig. 1 schematically illustrates an electric device comprising a display panel;
30 Fig. 2 schematically illustrates a display pixel arrangement according to a first embodiment of the invention;
 Fig. 3 schematically illustrates a display pixel arrangement according to a second embodiment of the invention;

Fig. 4 schematically illustrates a part of a display panel comprising a display pixel arrangement according to a third embodiment of the invention;

Fig. 5 schematically illustrates a part of a display pixel arrangement as employed in the display panel of Fig. 4;

5 Fig. 6 schematically illustrates a transparent LED based on a nanotube, and

Fig. 7 schematically illustrates a display panel incorporating display pixel arrangements according to an embodiment of the invention.

10 Fig. 1 shows an electric device 1 comprising a display panel 2 having a plurality of individually addressable display pixels 3 arranged in a matrix of rows 4 and columns 5. The display pixels 3 are positioned adjacent to each other. The display panel 2 may be a colour display panel 2 comprising display pixels 3 emitting red (R), green (G) and blue (B) light in predetermined groups. The display pixels 3 may be excited either by
15 electricity or by photoluminescence.

It is noted that the invention also relates to a light source with a pixel arrangement as defined in the claims. In the following paragraphs, the invention will be further described for a display panel 2.

Fig. 2 schematically shows a pixel arrangement 20 for a display panel
20 according to a first embodiment of the invention in perspective view and in side-view. The display pixel arrangement 20 comprises a first display pixel with a first emissive area 21 being located in a first plane I and a second display pixel with a second emissive area 22 being located in a second plane II. It should be appreciated that the display pixels typically comprise more components than only the emissive areas, such as electrode structures for
25 addressing as e.g. shown in Figs. 4-6. The arrows A indicate a viewing direction for an eye E normal to the planes I and/or II. The emissive areas 21, 22 are located such that they overlap in the direction A of viewing.

According to this embodiment of the invention the light emitted from the emissive area 21 has a linear first polarization indicated by the arrows P1 whereas the light
30 emitted from the second emissive area 22 has a second linear polarization indicated by the arrows P2 with an orientation perpendicular to the first polarization P1. The orthogonal orientation of the polarizations P1 and P2 enables light emitted from the first emissive area 21 to reach the eye E although the first emissive area 21 is overlapped by the second emissive area 22 in the viewing direction A.

Further the pixel arrangement 20 may comprise a third emissive area 23 in a third plane III that is adapted to pass light emitted from both the first emissive area 21 and the second emissive area 22. If the third emissive area has a polarization P3 it should be transparent for at least the light emitted from the emissive area with a polarization P1, P2
5 parallel to P3.

The pixel arrangement 20 may e.g. be a colour display pixel arrangement 20 wherein the first emissive area 21 emits e.g. red light, the second emissive area 22 emits green light and the third emissive area 23 emits blue light for a display panel. Such a display panel has several advantages over display panels with adjacent display pixels, such as for
10 example the enhancement of the brightness, even if less efficient material with a relative low local brightness is used. Further the degradation of the emissive material is reduced due to a lower current density at identical current in the display pixel. The daylight contrast might be also positive effected as the amount of reflective walls bounding the display pixels is reduced.

15 Fig. 3 schematically illustrates a pixel arrangement 30 according to a second embodiment of the invention in perspective view and in side-view. The pixel arrangement 30 comprises a first display pixel with a first emissive area 31 being located in a first plane I and a second display pixel with a second emissive area 32 being located in a second plane II. The arrows A indicate a viewing direction for an eye E normal to the planes I and/or II. The
20 emissive areas 31, 32 are located such that they overlap in the direction A of viewing.

The second emissive area 32 is substantially larger than the first emissive area 31. The second emissive area 32 may e.g. be two times the area of the first emissive area 31. Such a larger area 32 enables the use of light emissive materials with a low contribution per unit area to the light emission, such as nanowires. Alternatively the larger area 32 may be
25 used for light emitting substances that show fast degradation, such as blue light emitting organic materials. As a result of the larger emissive area 32, the current density for blue emissive areas can be reduced, resulting in a considerable increase in the life time.

According to this embodiment of the invention the light emitted from the emissive area 31 has a first linear polarization indicated by the arrows P1 whereas the light
30 emitted from the second emissive area 32 has a second linear polarization indicated by the arrows P2 with an orientation perpendicular to the first polarization P1. The orthogonal orientation of the polarizations P1 and P2 enables light emitted from the first emissive area 31 to reach the eye E although the first emissive area 31 is overlapped by the second emissive area 32 in the viewing direction A.

The display pixel arrangement 30 may further comprise at least a third emissive area 33 in the first plane I overlapped by at least said second emissive area 32 and having a third polarisation direction parallel to said first polarisation direction. Such an arrangement 30 may provide the basic colours R, G and B, wherein the first and third
5 emissive area 31, 33 are employed to emit the red and green light, whereas the second, larger, emissive area 32 is adapted to emit the blue light. It should be appreciated that the third emissive area 33 may also be located in a further plane different from the first plane I.

The dimensions of the first emissive area 31 can also be different from the dimensions of the third emissive area 33. Further, if the second emissive area emits blue light
10 and measures three times the area of a conventional display pixel configuration the lifetime is improved by more than one order of magnitude, whereas precise values depend e.g. on the driving conditions.

The embodiments of Fig. 2 and 3 may employ additional intermediate layers such as colour filters (not shown). If a colour filter is in some applications only required for
15 green, it is very difficult in a conventional display panel to apply it either locally only to the green sub-pixel or to find a good filter, which does not effect the other sub-pixels R and B. According to an embodiment of the invention first the green emissive area is prepared followed by deposition of a colour filter on top (without local restrictions). Finally the other two display pixels are deposited. The light emitted from these display pixels is not influenced
20 by the filter.

The polarisation directions P1, P2, P3 can be obtained by various processes, depending e.g. on the light emissive materials employed for the emissive areas 21, 31, 22, 32, 23, 33.

In an embodiment of the invention the light emissive materials comprise light
25 emitting polymeric materials (PLED) and/or light emitting small molecule (SMOLED) materials or materials used in light emitting electrochemical cells (LEEC). These materials have been found suitable to emit light if a current is conveyed through these materials. PLED materials provide advantages over SMOLED materials due to their intrinsic characteristics of thermal stability, flexibility and solubility in aqueous solutions or solvents. As a result PLED
30 materials can be applied by wet chemical techniques such as spincoating or ink jet deposition. The emissive areas may comprise several conductive polymer layers such as polyethylenedioxythiophene (PEDOT) layer and a polyphenylenevinylene (PPV), the latter being a light emitting polymer (LEP). In LEEC PLED materials are combined with one or

more ionic constituents to obtain a better performance for the injection of charge carriers enabling the use of conventional metallic electrodes for excitation.

The polarisation directions P1, P2 and P3 of the emissive areas can be obtained by inducing a crystal, crystal-like or preferential orientation for the above-mentioned materials. Polarization is a function of the orientation of the emitting macromolecules. Langemuir Blodgett techniques can be applied for the preparation of LEDs based on e.g. soluble poly(p-phenylene) (PPV) derivatives. The preferential orientation of the molecules is in the plane of the of the layer and parallel to the dipping direction, which is caused by inhomogeneous flow of the molecules to the substrate during transfer. It was shown that polarized electroluminescence can be obtained from these films [Ref: V. Cimrova, M. Remmers, D. Neher, G. Wegner, Adv. Mater. 1996, 8, 146.].

Such a structure or orientation can also be obtained by e.g blending the light emissive material with a liquid crystal (LC) solvent or by inducing an anisotropical character by means of oriented deposition, i.e. depositing the light emissive material such that it adopts a preferred orientation. Further, various process parameters may be influenced, such as the temperature. If e.g. the layers of light emissive material are deposited above the glass temperature and subsequently cooled sufficiently careful, the light emissive materials adopt a preferred orientation determining the polarisation direction of that particular emissive area. Another possibility to influence the polarisation directions P of the emissive areas is to modify the substrate before deposition of the light emissive material such that a preferred orientation is induced for the light emissive material on deposition.

In an embodiment of the invention the emissive areas 21, 31, 22, 32, 23, and/or 33 comprise light emissive nano-crystals, such as nanotubes, nanowires or light emitting organic materials in a crystalline state. Nanotubes per se are cheap, lightweight and easy to manufacture and to recycle.

Nanocrystals, i.e. nanotubes and nanowires, are small bodies having a more or less hollow (nanotubes) or filled (nanowires) cylindrical or prismatic shape having a smallest dimension, for example a diameter, in the nanometer range. These bodies have a symmetry axis, the orientation of which determines electrical and optical properties, such as the absorption characteristics of the material wherein they are embedded.

Nanowires, sometimes also referred to as filaments or whiskers, have been described for a variety of materials. Amongst them are nanowire of indium phosphide (InP) (X. Duan et al., Nature 409 (2001), 66; J. Wang et al., Science 293 (2001), 1455-1457), of zinc oxide (ZnO) (M. Huang et al., Science 292 (2001), 1897-1899), of gallium arsenide

(GaAs) and gallium phosphide (GaP) (K. Haraguchi et al., Appl. Phys. Lett. 60 (1992), 745; X. Duan et al., Nature 409 (2001), 66), of silicon carbide (SiC) (S. Motojima et al., J. Crystal Growth 158 (1996), 78-83), of boron nitride (BN) (W. Han et al., Applied Physics Letters 73, 21 (1998) 3085), of nickel dichloride (NiCl_2) (Y. Rosenfeld Hacoheh et al., Nature 395 (1998) 336), of molybdenum disulfide (MoS_2) (M. Remskar et al., Surface reviews and Letters, vol. 5 no. 1 (1998) 423), and tungsten disulfide (WS_2) (R. Tenne et al., Nature 360 (1992) 444).

Some materials are presently known to form nanotubes such as: carbon (C) (Iijima, S., Nature 354 (1991), 56-58; Ebbesen T W and Ajayan P M, Nature 358 (1992), 220) and silicon (Si) (B. Li et al., Physical Review B 59, 3, (1999), 1645), indium phosphide (InP) (E. Bakkers, M. Verheijen "Synthesis of InP nanotubes" J. Am. Chem. Soc. 2003, 125, 3440-3441.), MoS_2 and other materials).

Particularly carbon nanotubes have been well studied. They are one and/or multi-layered cylindrical carbon structures of basically graphitic (sp^2 -) configured carbon. The existence of both metallic and semi-conducting nanotubes has been confirmed experimentally. Furthermore, it has recently been found that single-walled 4 Å carbon nanotubes aligned in channels of an AlPO_4 -5 single crystal exhibit optical anisotropy. Carbon nanotubes are nearly transparent for radiation having a wavelength in the range of 1.5 μm down to 200 nm and having a polarization direction perpendicular to the tube axis. They show strong absorption for radiation having a wavelength in the range of 600 nm down to at least 200 nm and having a polarization direction parallel to the tube axis (Li Z M et al., Phys. Rev. Lett. 87 (2001), 127401-1 - 127401-4).

Similar properties have been found for nanotubes (or nanowires) other than those consisting of carbon.

In the embodiments in which photoluminescent light emitting materials are used for the light emissive areas 21, 31, 22, 32, 23, and/or 33, nanocrystals are preferred.

Photoluminescent nanocrystals conveniently combine the following features: they absorb light, said absorption properties being effective in a broad range of wavelengths, said absorption also being a function of the orientation of the nanocrystals relative to a plane of polarization of said light, and the orientation of nanotubes can be directed and/or stabilized mechanically and/or by an electric field. Thus the direction of the nanocrystals can be arranged such that they show absorption for light polarized in a particular plane P1, P2, while being transparent for light that is differently polarized P2, P1.

There are various ways for aligning the nanocrystals.

The nanocrystals can be aligned in a preferential direction for instance by applying an electrical AC or DC field in the order of $0.2\text{V}/\mu\text{m}$ [see. e.g. K. Yamamoto et al., J. Phys. D: Appl. Phys. 31 (1998), 34-36 and ; X. Duan et al., Nature 409 (2001), 66].

Furthermore directed/aligned growth of nanotubes is achieved by catalytic CVD methods with simultaneously applying an electrical field, as reported by e.g. Y. Zhang et al, Appl. Phys. Lett., vol. 79, no. 19, 3155 (2001).

The nanotubes exhibit a very large anisotropy in optical absorption, e.g. depending on the relative orientation of the incident radiation and the physical orientation of the tubes one can provide a difference in absorption coefficient of approximately 10^6 in the UV region. Thus, well aligned nanotubes are absorbing light with a polarization P1 parallel to the tube axis, while for light with a perpendicular polarization P3 the nanotubes are transparent.

Furthermore, nanocrystals have been shown to have luminescence properties. For example, single walled carbon nanotubes formed in micro-channels of zeolite crystals emit light in the visible region upon excitation (N. Nagasawa et al., Journal of Luminescence 97 (2002), 161-167). Such properties are also known from other types of nanocrystals, (J.-M. Bonard et al., Phys. Rev. Lett. Vol. 81, no. 7, 1441 (1998); M.H. Huang et al., Science vol. 292 (2001), 1897; K. Yamamoto et al., J. Phys. D: Appl. Phys. 31 (1998), 34-36; X. Duan et al., Nature 409 (2001), 66 ; J. Wang et al., Science vol. 293 (2001), 1455). The emitted (luminescent) light is polarized depending on the orientation of the light emitting nanocrystal. It is reported that the plane of polarization P1, P2 is often the same as that of the absorbed light(N. Nagasawa et al., vide supra).

Upon excitation the nanocrystals exhibit emission in the visible region, which has as an extra feature that the emission is polarised depending on the orientation of the nanocrystals. Only nanocrystals in the absorbing mode are excited and can therefore submit light. It is reported that the emitted light has the same polarization as the absorbed light.

The excitation can be done by light, e.g. UV light, in which case the device 1 comprises a light source (not shown). However, excitation can also be done by electroluminescence, since nanocrystals have been found to exhibit also electroluminescence, wherein the emitted light has, as is the case for photoluminescence, a strong polarization dependency. In case of electroluminescent nanocrystals, electrodes are provided to apply voltage differences over the nanocrystal areas (see e.g. Fig. 4).

Figs. 4-6 schematically illustrate some of the above-described concepts employing nanocrystals

Fig. 4. schematically illustrates a part of a display panel comprising various display pixel arrangements 20 without the third emissive area 23 as was shown Fig. 2. The display pixels with the first emissive areas 21 in the plane I comprise electrodes 40 and the display pixels with the second emissive area 22 in the plane II comprise electrodes 41, while the second emissive areas 22 overlap the first emissive areas 21. The electrodes 40, 41 have a fork-shape in between which light emitting materials are provided, such as nanocrystals 43. By applying appropriate voltages over the electrode 40, 41 light can be induced from the nanocrystals 43. As a result of the specific polarisation directions P1 and P2, the light from the first emissive areas 21 passes the overlapping second emissive areas 22.

Fig. 5 schematically shows a method for producing a display panel based on InP nanowires 50. A porous alumina (Al_2O_3) matrix 51 is formed by anodizing an aluminium film on a substrate 52. Pores with a diameter in the range of 5-50 nm are formed with a density of 10^{10} pores/ cm^2 . Gold (Au) particles are electrochemically deposited at the bottom of the pores to form layer 54. By switching the target during the synthesis, a p-n junction 55 within a wire or tube is formed. After growth, the top surface is polished and a transparent electrode (ITO) 56 is deposited. Light is induced by application of a voltage V over the p-n junction, which light exits the structure through the transparent ITO-layer 56.

Fig. 6 illustrates a transparent LED based on a compound semiconductor nanotube 60. In the tube 60 a n-p junction 61 is established. The tube 60 is contacted with an ohmic contact 62 to the n-part of the junction 61 as an electron injecting electrode and an ohmic contact 63 to the p-part of the junction as a hole-injecting electrode. Injection of electrons and holes induces light at the p-n junction. The LED is made on a SiO_2 substrate 64 through which the light may be transmitted.

It should be appreciated that the emissive areas may comprise different types of light emissive materials within a single display pixel arrangement 20, 30. For example, in Fig. 3 the first emissive area 31 may comprise a red light emitting PLED material and the third emissive area 33 may comprise a green light emitting PLED material, whereas the second emissive area 32 may comprise nanowires for emitting blue light.

Finally, Fig. 7 schematically illustrates a display panel 70 incorporating display pixel arrangements 20, 30 according to an embodiment of the invention. The display panel 70 has a data input 71 for receiving a data signal to be displayed by the panel 70, i.e. by the plurality of display pixel arrangements 20, 30 described above. The display panel 70 further comprises means, such as the electrodes 40, 41 in Fig. 4 or a light (not shown) for

photoluminescence, to induce light of the individually addressable first, second and third emissive areas.

It is noted that the pixel arrangements 20, 30 can also be used for a light source or elements of a light source.

CLAIMS:

1. Pixel arrangement (20;30) for an emissive device (70) with at least a first emissive pixel and a second emissive pixel, said first emissive pixel and said second emissive pixel having respectively a first emissive area (21;31) and a second emissive area (22;32) adapted to emit light upon excitation, said first emissive area (21;31) being located in a first
5 plane (I) and said second emissive area (22;32) being located in a second plane (II) such that said first emissive area (21;31) and said second emissive area (22;32) at least partially overlap in a viewing direction (A) normal to at least one of said planes (I,II), wherein said first emissive area (21;31) is adapted to emit light with a first polarization direction (P1) and said second emissive area (22;32) is adapted to emit light with a second polarization direction
10 (P2) oriented substantially perpendicular to said first polarization (P1).
2. Pixel arrangement (20;30) according to claim 1, further comprising a third emissive area (23;33) in a third plane (III), said third emissive area (23;33) at least partially overlapping at least one of said first emissive area (21;31) and said second emissive area
15 (22;32) in said viewing direction (A) and being optically transparent for light emitted from at least one of said first emissive area (21;31) and said second emissive area (22;32).
3. Pixel arrangement (20) according to claim 1, further comprising third emissive area (23) in a third plane (III), said third emissive area (23) at least partially overlapping both
20 said first emissive area (21;31) and said second emissive area (22) in said viewing direction (A) and having a third polarisation direction (P3) parallel to either said first polarisation direction (P1) or said second polarisation direction (P2) and being optically transparent for light emitted from respectively said first emissive area (21) or said second emissive area (22).
- 25 4. Pixel arrangement (30) according to claim 1, wherein said second emissive area (32) is larger than said first emissive area (31).
5. Pixel arrangement (30) according to claim 4, wherein said arrangement (30) further comprises at least a third emissive area (33) in said first plane (I) or a further plane,

said third emissive area (33) being overlapped by at least said second emissive area (32) and having a third polarisation direction (P3) parallel to said first polarisation direction (P1).

6. Pixel arrangement (30) according to claim 4 or 5, wherein said second
5 emissive area (32) comprises light emitting materials with a lower efficiency and/or faster degradation behaviour than light emitting materials of said first emissive area (31).
7. Pixel arrangement (20;30) according to claim 1, wherein said first and second
10 emissive areas (21,22;31,32) comprise organic light emitting materials, such as light emitting polymeric materials and/or light emitting small molecule materials and/or materials used in light emitting electrochemical cells.
8. Pixel arrangement (20;30) according to claim 1, wherein said first and second
15 emissive areas (21,22;31,32) comprise light emissive nanocrystals (43), such as nanotubes or nanowires, or light emitting organic materials in a crystalline state.
9. Pixel arrangement (20;30) according to claim 1, wherein said first and second
emissive areas (21,22;31,32) are adapted to emit different colours (R,G,B).
- 20 10. Pixel arrangement (20;30) according to claim 1, wherein a colour filter layer is present between said first emissive area (21;31) and said second emissive area (22;32).
11. Display panel (70) comprising a plurality of pixel arrangements (20;30)
25 according to claim 1 as emissive display pixels, wherein each of said emissive display pixels is individually addressable and said display panel (70) further comprises means (40,41) to have at least one of said first and second emissive area (21,22;31,32) emit light in accordance with a data signal for said display panel (70).
12. Light source comprising a plurality of pixel arrangements (20;30) according to
30 claim 1 and a source to provide power to said pixel arrangements (20;30).

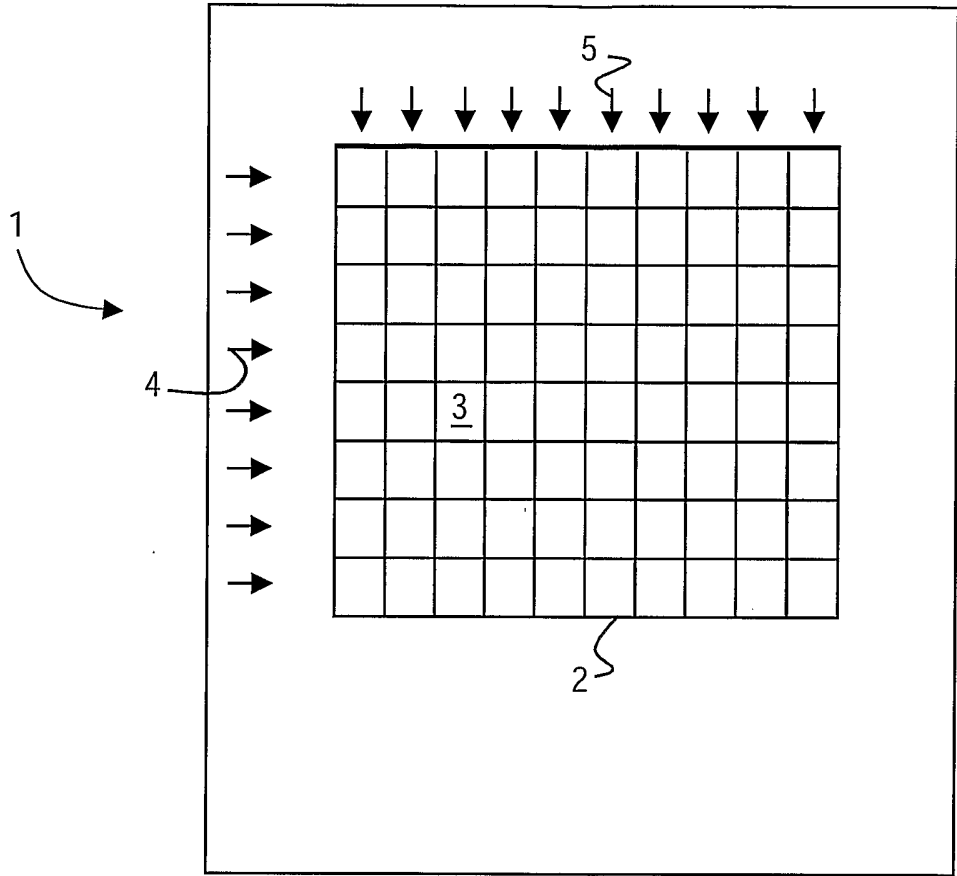


FIG.1

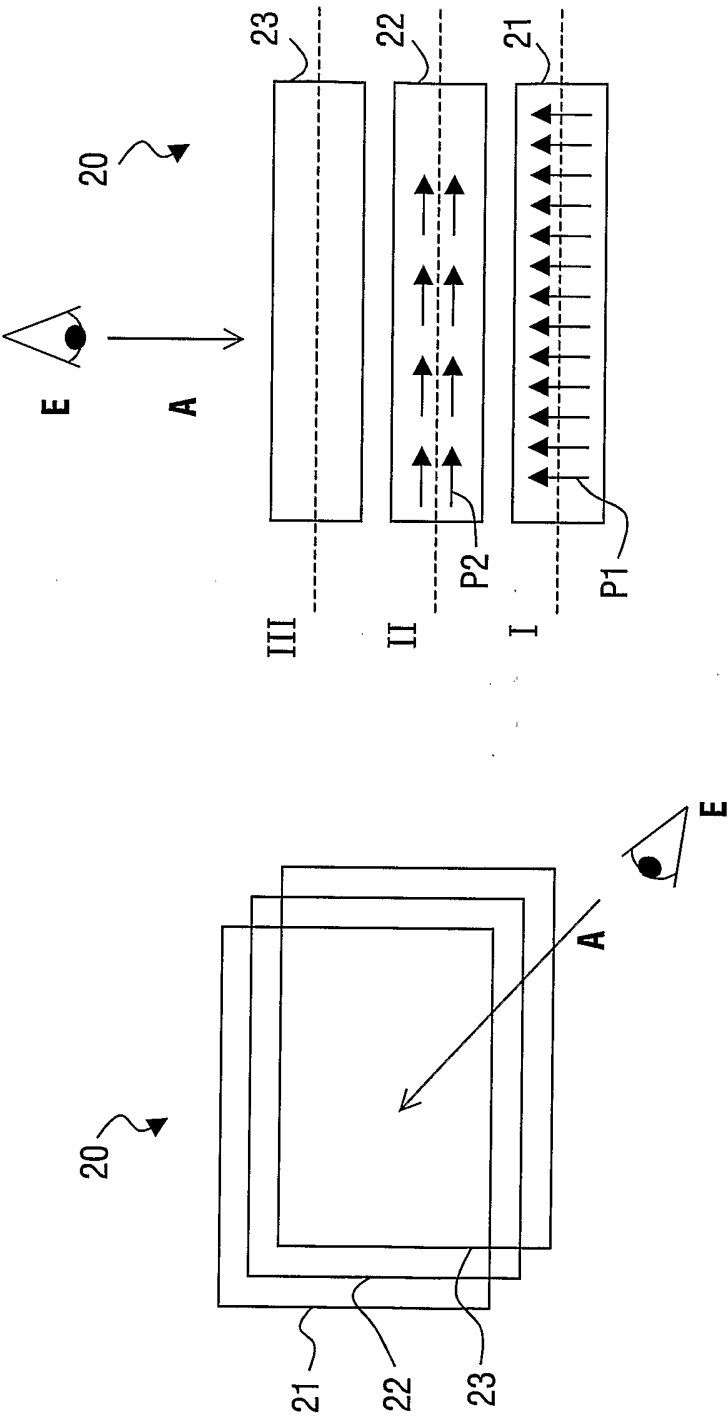


FIG.2

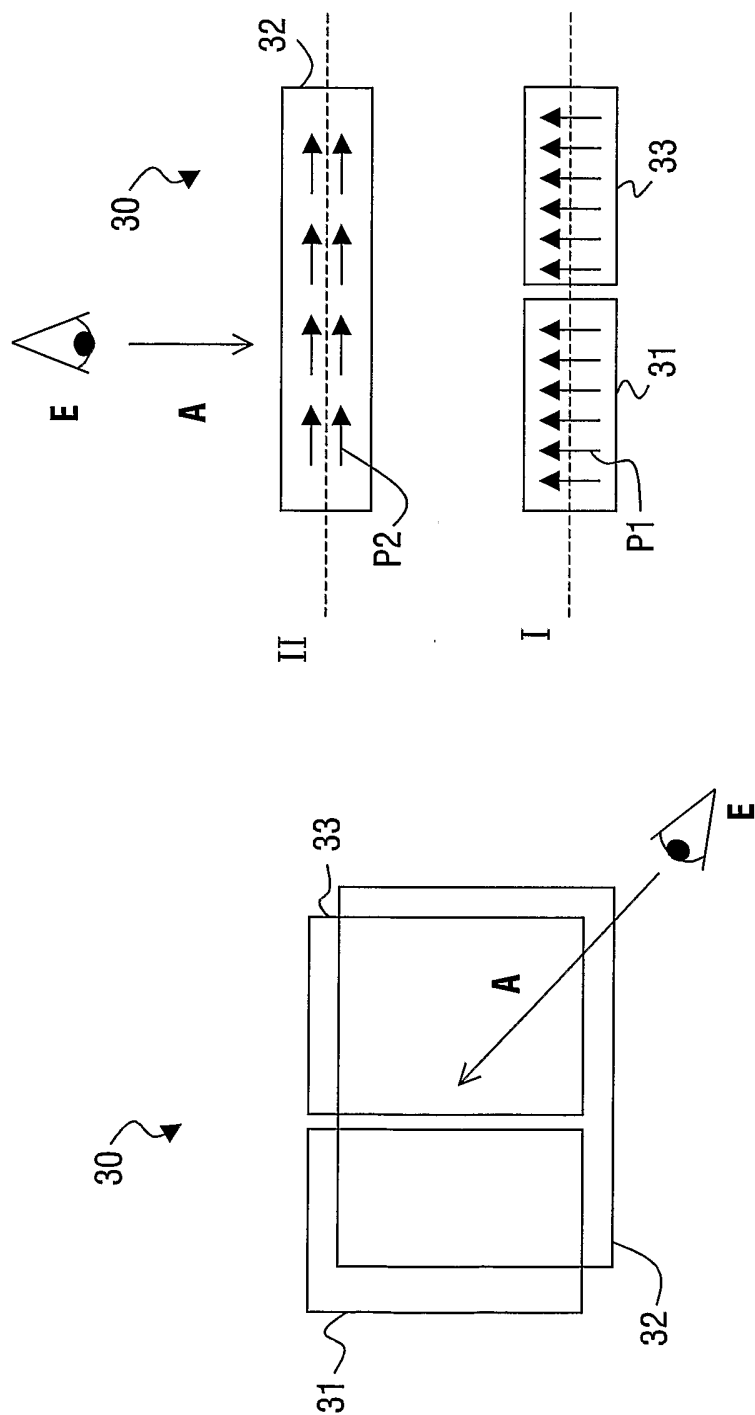


FIG.3

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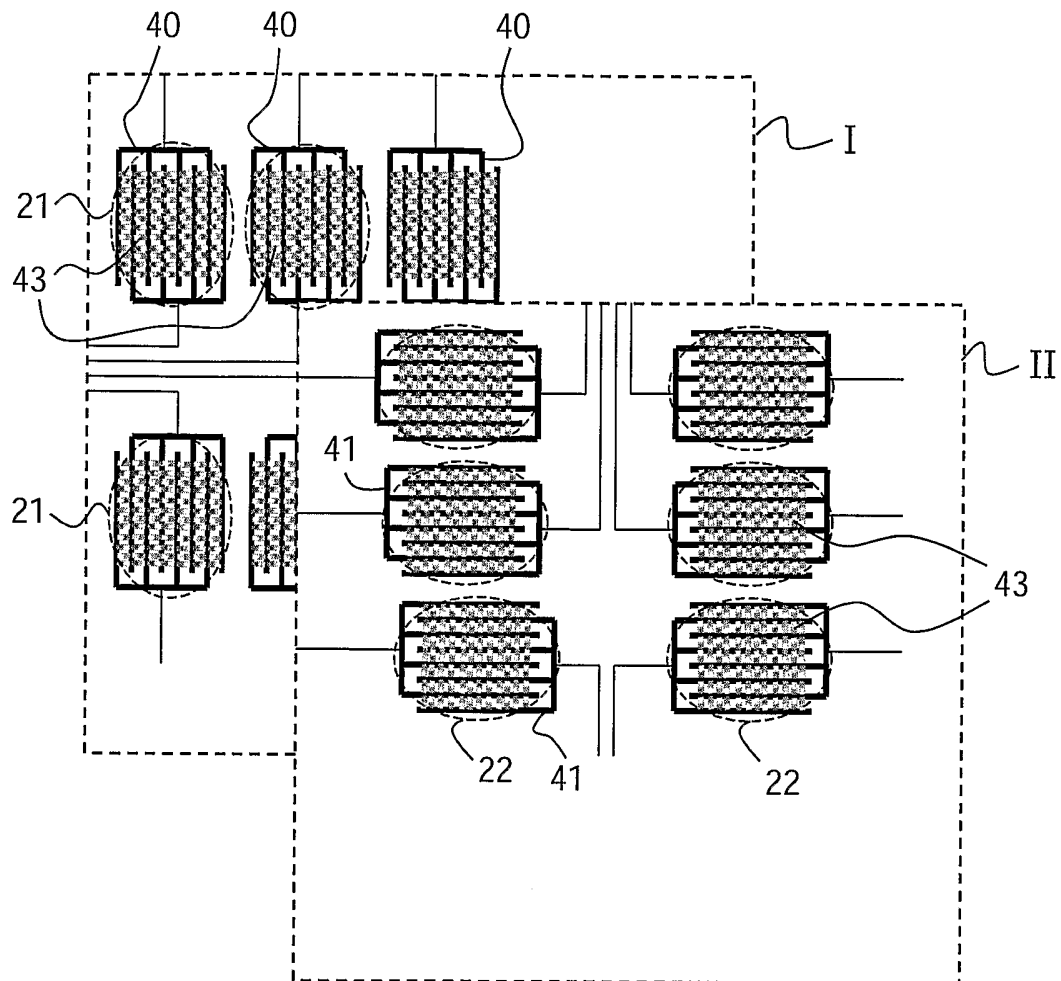


FIG.4

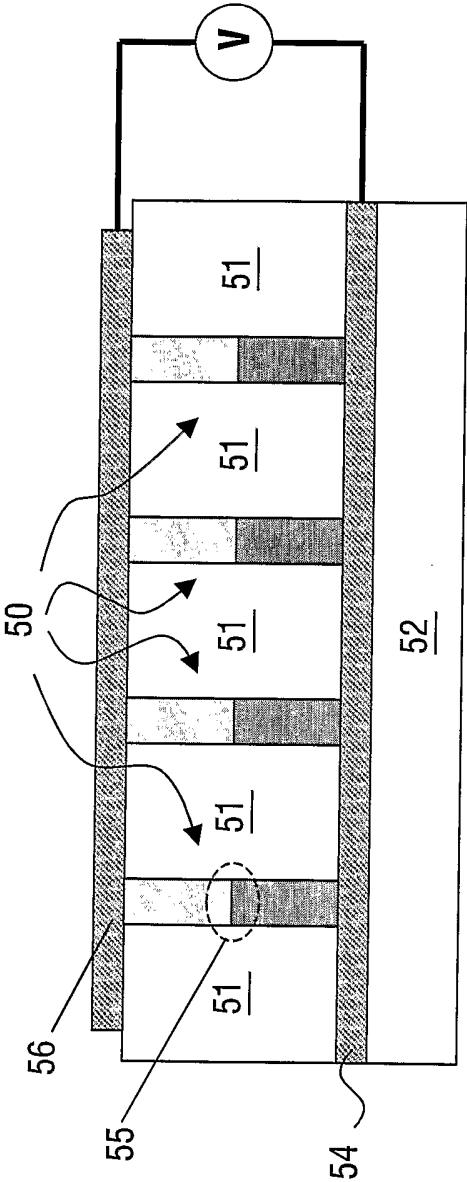


FIG.5

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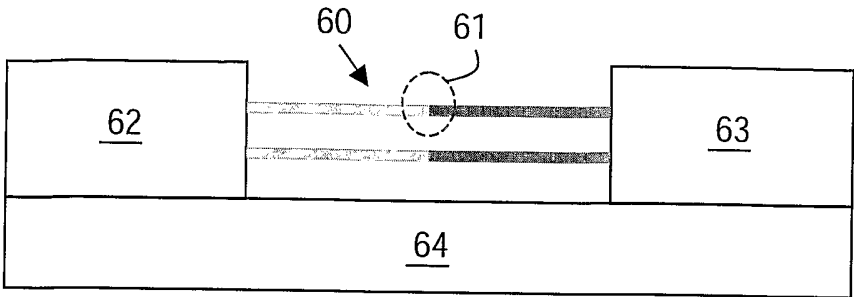


FIG.6

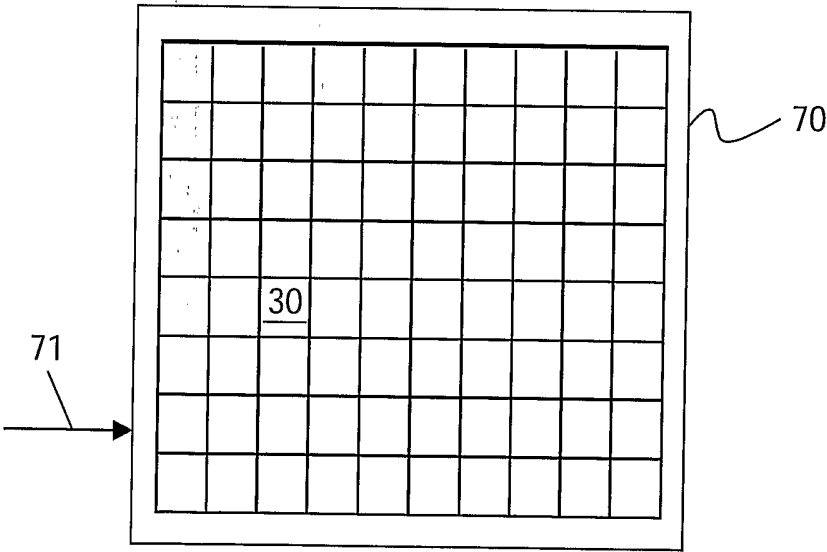


FIG.7

INTERNATIONAL SEARCH REPORT

Int. Application No
PCT/JP2004/052520

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H01L51/20

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Y		4-6, 8, 11, 12
Y	----- PATENT ABSTRACTS OF JAPAN vol. 2003, no. 06, 3 June 2003 (2003-06-03) -& JP 2003 036973 A (PIONEER ELECTRONIC CORP), 7 February 2003 (2003-02-07) abstract; figure 5 -----	4-6
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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

15 April 2005

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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