(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 291 703 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention
of the grant of the patent:
30.11.2016 Bulletin 2016/48

(21) Application number: **09735427.8**

(22) Date of filing: **22.04.2009**

(51) Int Cl.:
G02F 1/13363 $^{(2006.01)}$

(86) International application number:
PCT/IB2009/051660

(87) International publication number:
WO 2009/130676 (29.10.2009 Gazette 2009/44)

(54) COLOR LIQUID CRYSTAL DISPLAY AND COMPENSATION PANEL

FARBFLÜSSIGKRISTALLANZEIGE UND KOMPENSATIONSSCHIRM

ÉCRAN À CRISTAUX LIQUIDES COULEUR ET PANNEAU DE COMPENSATION

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK TR

(30) Priority: **25.04.2008 US 47876 P**
20.04.2009 US 426329

(43) Date of publication of application:
09.03.2011 Bulletin 2011/10

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Printed by Jouve, 75001 PARIS (FR)

Description

FIELD OF THE INVENTION

[0001] This invention relates to a color liquid crystal display (LCD) device and, more particularly, to the improvement of color LCDs by using compensation panel with spectrally controllable dispersion of refractive indices.

BACKGROUND OF THE INVENTION

[0002] Liquid crystal displays are widely used in watches and clocks, photographic cameras, various instruments, computers, flat television sets, projection screens, and numerous information devices.

[0003] Electro-optical modes employed in LCDs include, in particular, the twisted nematic (TN), super twisted nematic (STN), optically compensated bend (OCB), and electrically controlled birefringence (ECB) modes, as well as some others and with their various modifications. All these modes use an electric field, which is substantially perpendicular to the substrate and, hence, to the liquid crystal (LC) layer. Besides these modes, there are several electro-optical modes employing an electric field substantially parallel to the substrate and, hence, to the liquid crystal layer, for example, the in-plane switching.

[0004] The in-plane switching (IPS) and vertically aligned (VA) modes are the most widely used in LCDs for large scale modem desktop monitors and TV sets, and are envisaged for use in future displays for multimedia applications.

[0005] A TN (twisted nematic) mode LCD is a common type of conventional LCD using liquid crystal molecules that have positive dielectric anisotropy and are horizontally aligned in a twisted state between two substrates. However the TN LCDs cannot display an absolute black state because of hardly compensated light leakage. On the other hand, the IPS LCD can display an almost complete black state in an OFF-state because the liquid crystal molecules are aligned almost horizontally and uniformly by the surfaces of the substrates so that the light polarized linearly along the LC optical axis undergoes no change in polarization sate when passes through the liquid crystal layer. The VA mode LCD is also characterized by uniform distribution of LC molecules in the OFF-state. However, for a high-quality optical compensation of VA LCD one needs using at least two different types of the retardation films. Thus the light leakage remains a problem to be solved.

[0006] In connection with polarizing plates, compensation panel, retardation layers described in the present application, the following definitions of terms are used throughout the text.

[0007] The term optical axis refers to a direction in which the different linearly polarized components of propagating light have the same phase velocity and do not exhibit mutual retardation.

[0008] Any optically anisotropic medium is characterized by its second-rank dielectric permittivity tensor. A dielectric permittivity of any medium is determined by polarizability of particles forming this medium. If medium comprises supramolecules then dielectric permittivity of the medium is determined by orientation and polarizability of these supramolecules.

[0009] The classification of compensation panels is tightly connected to orientations of the principal axes of a particular permittivity tensor with respect to the natural coordinate frame of the compensation panel. The natural *xyz* coordinate frame of the panel is chosen so that the z-axis is parallel to the normal direction and the *xy* plane coincides with the panel surface.

[0010] Figure 1 (prior art) demonstrates a general case when the principal axes (*A, B,* C) of the permittivity tensor are arbitrarily oriented relative to the *xyz* frame. Orientations of the principal axes can be characterized using three Euler's angles (θ, φ, ψ) which, together with the principal permittivity tensor components (ε_A, ε_B, ε_C), uniquely define different types of optical compensators. The case when all the principal components of the permittivity tensor have different values corresponds to a biaxial compensator, whereby the panel has two optical axes. For instance, in case of $\varepsilon_A < \varepsilon_B < \varepsilon_C$, these optical axes are in the plane of C and A axes on both sides from the C axis. In the uniaxial limit, when $\varepsilon_A = \varepsilon_B$, a degenerated case takes place when the two axes coincide and the C axis is a single optical axis.

[0011] In another example two principal axes *A* and *B* of the dielectric tensor lie in the panel plane, while the C-axis is normal to it. The *x, y* and *z*-axes of the laboratory frame can be chosen coinciding with A, B and C axes respectively. If, for instance, the lowest and highest magnitudes of three principal values ε_A, ε_B, and ε_C of the dielectric permittivity tensor correspond to the *A* and *B* axes respectively, then $\varepsilon_A < \varepsilon_C < \varepsilon_B$, and two optical axes belong to the *AB* plane. For this reason such retardation layer is named "A_B" or "B_A" type panel (Figure 2, prior art). The negative A_B panel, when $\varepsilon_A - \varepsilon_B < 0$, is equivalent to positive B_A panel or plate (replacing the order of the naming letters changes the sign of the dielectric permittivity difference: $\varepsilon_B - \varepsilon_A > 0$). Another fundamentally different case is when two optical axes belong to the plane orthogonal to the panel surface. This case takes place if the lowest or highest magnitude of one of the principal permittivity corresponds to the C-axis. For instance, in case of $\varepsilon_C < \varepsilon_B < \varepsilon_A$ the retardation layer is named negative C_A or positive A_C panel.

[0012] The zenith angle θ between the C axis and the z axis is most important in the definitions of various compensation types. There are several important types of uniaxial retardation layers, which are most frequently used in practice for compensation of LCD.

[0013] If a panel is defined by Euler angle $\theta=\pi/2$ and $\varepsilon_A = \varepsilon_B \neq \varepsilon_C$ then it is called "A-panel". In this case the principal C-axis lies in the panel plane (*xy*-plane), while A-axis is normal to the plane surface (due to the uniaxial degeneration the orthogonal orientations of A and B-axes can be chosen arbitrary in the plane that is normal to the *xy*-surface). In case of $\varepsilon_A = \varepsilon_B < \varepsilon_C$ the panel is named "positive A-panel" (Figure 3(a), prior art). Contrary, if $\varepsilon_A = \varepsilon_B > \varepsilon_C$ the panel is named "negative A-panel" (Figure 3(b), prior art).

[0014] A C-panel is defined by the Euler angle $\theta = 0$ and $\varepsilon_A = \varepsilon_B \neq \varepsilon_C$. In this case, the principal C axis (extraordinary axis) is normal to the panel surface (*xy* plane). In case of $\varepsilon_A = \varepsilon_B < \varepsilon_C$, the panel is named "positive C-panel". On the contrary, if $\varepsilon_A = \varepsilon_B > \varepsilon_C$, the panel is named "negative C-panel". Figure 4 (Prior art) shows the orientation of the principal axes of a particular permittivity tensor with respect to the natural coordinate frame of the positive (a) and negative (b) C-panel. The axes OA and OB located in a *xy* plane are equivalent.

[0015] Generally when the permittivity tensor components (ε_A, ε_B, and ε_C) are complex values, the principal permittivity tensor components (ε_A, ε_B, and ε_C), the refractive indices (na, nb, and nc), and the absorption coefficients (ka, kb, and kc) meet the following conditions: $na = \mathrm{Re}[(\varepsilon_A)^{1/2}]$, $nb = \mathrm{Re}[(\varepsilon_B)^{1/2}]$, $nc = \mathrm{Re}[(\varepsilon_C)^{1/2}]$, $ka = (4\pi/\lambda,)\mathrm{Im}[(\varepsilon_A)^{1/2}]$, $kb = (4\pi/\lambda)\mathrm{Im}[(\varepsilon_B)^{1/2}]$, $kc = (4\pi/\lambda)\mathrm{Im}[(\varepsilon_C)^{1/2}]$, where λ is a free space wavelength.

[0016] The optical characteristics of LCD devices can be improved by application of one or more layers having optical birefringence. In the conventional commercial displays the retardation layers (or retardation films) are used in order to solve the problems of low contrast and light leakage. The typical retardation film consists of at least one homogeneous layer of uni- or biaxial birefringent material, and is disposed between a polarizer and a liquid crystal cell. The retardation film for compensation of contrast ratio at oblique viewing angles comprises a negative C-type panel for compensating an in-plane retardation (R_{in}), and a negative A-type panel for compensating out-of-plane retardation (R_{out}) which should be placed in a specific order to increase the contrast at wide viewing angles.

[0017] However, typical retardation films have a normal dispersion and cannot provide the solution to the above referenced disadvantages in the entire visible spectral range. It can result in the distortion of color of the displayed picture, especially at wide viewing angles. Usually the optimization of LCD is held in the maximal sensitivity human eye vision range for the light wavelength of 550 nm. Therefore, the maximal distortions arise in the red and blue parts of the light spectrum. In the present invention it is supposed that the visible spectral range has a lower boundary that is approximately equal to 400 nm, and an upper boundary that is approximately equal to 750 nm.

[0018] WO2007/086599 discloses a liquid crystal display device comprising a cellulose acylate film having an in-plane retardation (Re) and a retardation in a thickness direction (Rth) satisfying relations of equations (1) to (6), and has a thickness of 30 μm or greater but less than 70 μm: 20 nm < Re(548) < 100 nm (1), 100 nm < Rth(548) < 400 nm (2), 0.5 < Re(446)/Re(548) < 0.90 (3), 1.05 < Re(629)/Re(548) < 1.50 (4), 0.5 < Rth(446)/Rth(548) < 0.95 (5), 1.05 < Rth(629)/Rth(548) < 1.50 (6)". Thus the in-plane retardation (Re) and retardation in the thickness direction (Rth) of the cellulose acylate film increases at a longer wavelength and thus possesses the reverse dispersion characteristics. The cellulose acylate film may comprise a plurality of ultraviolet absorbers.

[0019] Figure 5 (prior art) demonstrates a typical liquid crystal cell 1 of a color liquid crystal display. The liquid crystal cell comprises front substrate 2 with color filters 3, black matrix 4 and planarization layer 5; liquid crystal layer 6; other functional layers 7 comprising electrode and alignment layers; and a back substrate 8 with electrodes, driving elements and alignment layers.

[0020] The present invention provides a compensated color liquid crystal display with improved optical performance, in particular, higher contrast and better color rendering at a wide range of viewing angles, and reduced color shift in an entire viewing angle range. These advantages are provided along with the simplified manufacturing technology.

SUMMARY OF THE INVENTION

[0021] The present invention provides an optically anisotropic compensation panel comprising at least one optically anisotropic layer on a substrate, the compensation panel possessing a spectrally controlled dispersion of refactive indices, wherein the the layer is based on an ordered guest-host system comprising an ordered anisotropic host matrix comprising an organic compound transparent to electromagnetic radiation in the visible spectral range, and having three principal refractive indices ($n_{x,h}$, $n_{y,h}$ and $n_{z,h}$) possessing a normal spectral dispersion $\partial n_{u}(\lambda/ \partial\lambda < 0$ in the visible spectral range, wherein the subscript u is selected from the list comprising x, y and z; and an ordered guest component comprising guest particles, the guest particles being optically anisotropic dye molecules that provide an absorption additional to an absorption of the anisotropic host matrix, realized in at least one principal direction of the anisotropic host matrix in at least one subrange of visible spectral range; such that the optically anisotropic layer has three principal refractive indices (n_x, n_y and n_z), at least one of which satisfies the following condition where $\partial n_u(\lambda)/ \partial\lambda \geq 0$ in at least one subrange of the visible spectral range, and wherein the subscript u is selected from the list comprising x, y and z.

[0022] The anisotropic host matrix may have further properties selected from:

a) biaxial properties of B_A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$ and/or out-of-plane difference of refractive indices $\Delta_{out,h}(\lambda) = | n_{x.h}(\lambda) - n_{z,h}(\lambda) |$;

b) uniaxial properties of positive A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$;

c) uniaxial properties of negative A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$;

d) biaxial properties of A_C-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$ and/or out-of-plane difference of refractive indices $\Delta_{out,h}(\lambda) = | n_{x.h}(\lambda) - n_{z,h}(\lambda) |$;

e) uniaxial properties of positive C-type having an out-of-plane difference of refractive indices $\Delta_{out,h} (\lambda) = | n_{x.h}(\lambda) - n_{z,h}(\lambda) |$; and

f) uniaxial properties of negative C-type having an out-of-plane difference of refractive indices $\Delta_{out,h} (\lambda) = | n_{x.h}(\lambda) - n_{z,h}(\lambda) |$;

wherein for each of b) to f) condition $\partial\Delta_{out,h} (\lambda)/\partial\lambda <0$ and/or condition $(\partial\Delta_{in,h}(\lambda)/\partial\lambda <0$ are satisfied in the visible spectral range.

[0023] In a further aspect, the present invention provides a color liquid crystal display comprising a liquid crystal cell, first and second polarizers arranged on each side of the liquid crystal cell, and at least one compensation panel as disclosed located between said polarizers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] The subject of the invention is illustrated by the following Figures, of which:

Figures 1 to 5 are described hereinabove as illustrations to prior art.
Figure 6 is a diagram showing a construction of a liquid crystal display according to a first embodiment of the present invention.
Figure 7 is a diagram showing a construction of a liquid crystal display according to a second embodiment of the present invention.
Figure 8 is a diagram showing a construction of a liquid crystal display according to a third embodiment of the present invention.
Figure 9 is a diagram showing a construction of a liquid crystal display according to a fourth embodiment of the present invention.
Figure 10 is a diagram showing a construction of a liquid crystal display according to a fifth embodiment of the present invention.
Figure 11 is a diagram showing a construction of a liquid crystal display according to a sixth embodiment of the present invention, wherein the compensation panel is located inside the liquid crystal cell.
Figure 12 shows the calculated refractive indices (n_x, $n_{y,}$ and n_z) of the optically anisotropic layer according to the first embodiment of the disclosed anisotropic layer.
Figure 13 shows the calculated refractive indices (n_x, $n_{y,}$ and n_z) of the optically anisotropic layer according to the second embodiment of the disclosed anisotropic layer.
Figure 14 shows the calculated refractive indices (n_x, $n_{y,}$ and n_z) of the optically anisotropic layer according to the third embodiment of the disclosed anisotropic layer.
Figure 15 shows the calculated refractive indices (n_x, $n_{y,}$ and n_z) of the optically anisotropic layer according to the fourth embodiment of the disclosed anisotropic layer.
Figure 16 shows the calculated refractive indices ((n_x, $n_{y,}$ and n_z) of the optically anisotropic layer according to the fifth embodiment of the disclosed anisotropic layer.
Figure 17 shows the calculated refractive indices (n_x, $n_{y,}$ and n_z) of the optically anisotropic layer according to the sixth embodiment of the disclosed anisotropic layer.
Figure 18 shows a comparison of refractive indices (n_x, $n_{y,}$ and n_z) of two optically anisotropic layers, wherein one of them (see, dashed line) was prepared from a solution comprising a binary mixture of host compound and guest particles and another (see, continuous line) was prepared from a solution comprising a threefold mixture of a host compound and guest particles of two types.
Figure 19 is a diagram showing a construction of a liquid crystal display according to a seventh embodiment of the present invention, wherein the compensation panel is located outside the liquid crystal cell.
Figure 20 shows a change of the color state of VA-LCD without dispersion compensation versus time during field-

driven switching from BLACK to WHITE states.

Figure 21 shows the refractive indices n_x, n_y, and n_z having normal spectral dispersion.

Figure 22 illustrates the mechanism of formation of an anomalous dispersion.

Figure 23 schematically shows the mixture is capable to form a guest-host system according to the present invention.

Figure 24 shows the principal refractive index n_y possessing anomalous spectral dispersion ($\partial n_y(\lambda)/\partial\lambda \geq 0$) in the subrange from 450 nm to 575 nm.

Figure 25 shows a change of the color state of VA-LCD with dispersion compensation versus time during field-driven switching from BLACK to WHITE states.

Figures 26a - 26c show computer simulated viewing angle contrast-ratio map for IPS LCD design without dispersion compensation for three wavelength: λ = 450nm - Figure 26 (a), λ = 550 nm - Figure 26 (b), λ = 630 nm - Figure 26 (c).

Figure 27 shows a change of the color state of IPS-LCD without dispersion compensation versus time during field-driven switching from BLACK to WHITE states.

Figure 28 shows the spectral absorption (Figure 28a) and spectral refractive indices (Figure 28b) of modified A_B panel.

Figure 29 shows a computer simulated viewing angle contrast-ratio map of color-compensated IPS LCD design for three wavelengths: λ = 450 nm - Figure 29 (a), λ = 550 nm - Figure 29 (b), λ = 630 nm - Figure 29 (c).

Figure 30 shows a change of the color state of IPS-LCD with dispersion compensation versus time during field-driven switching from BLACK to WHITE states.

DETAILED DESCRIPTION OF THE INVENTION

[0025] Definitions of various terms used in the description and claims of the present invention are listed below.

[0026] The term "visible spectral range" refers to a spectral range having the lower boundary approximately equal to 400 nm, and upper boundary approximately equal to 750 nm.

[0027] The term "compensation panel" refers to an optical device which includes at least one optically anisotropic layer which is characterized by three principal refractive indices (n_x, n_y and n_z), wherein two principal directions for refractive indices n_x and n_y belong to xy-plane coinciding with a plane of the compensation panel and one principal direction for refractive index (n_z) coincides with a normal line to the compensation panel (the in-plane *x* and *y* axes are chosen so they always coincide with the in-plane principal axes).

[0028] The term " in-plane difference of refractive indices $\Delta_{in}(\lambda)$" is defined as an absolute value of a difference of two in-plane indexes $| n_y(\lambda) - n_x(\lambda) |$ and characteristic of in-plane optical anisotropy.

[0029] The term "out-of-plane difference of refractive indices $\Delta_{out}(\lambda)$" is defined as an absolute value of a difference of vertical index n_z and one in-plane index n_x: $| n_z(\lambda) - n_x(\lambda) |$ and characteristic of out-of-plane optical anisotropy.

[0030] The term "optically anisotropic layer of B_A-type" refers to an optical layer for which refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_y > n_z > n_x$ or $n_x > n_z > n_y$

[0031] The term "optically anisotropic layer of negative A-type" refers to an optical layer for which refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_z = n_y > n_x$ or $n_z = n_x > n_y$

[0032] The term "optically anisotropic layer of positive A-type" refers to an optical layer for which refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_z = n_x < n_y$. or $n_z = n_y < n_x$

[0033] The term "optically anisotropic layer of A_C-type" refers to an optical layer for which refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_y > n_x > n_z$ or $n_x > n_y > n_z$ (positive Ac -type) or $n_y < n_x < n_z$ or $n_x < n_y < n_z$.((negative Ac -type)

[0034] The term "optically anisotropic layer of negative C-type" refers to an optical layer for which refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_x = n_y > n_z$.

[0035] The term "optically anisotropic layer of positive C-type" refers to an optical layer for which refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_x = n_y < n_z$.

[0036] The above mentioned definitions are invariant to rotation of system of coordinates (of the laboratory frame) for 90 degrees around the vertical 0z-axis for all the types of anisotropic layers.

[0037] The term "guest-host system" refers to an optical system comprising host matrix and a guest component, wherein the host matrix is characterized by three principal refractive indices ($n_{x,h}$, $n_{y,h}$ and $n_{z,h}$), two principal directions for refractive indices $n_{x,h}$ and $n_{y,h}$ belong to xy-plane coinciding with a plane of the compensation panel, and one principal direction for refractive index ($n_{z,h}$) coincides with a normal line to the compensation panel.

[0038] The term "anisotropic host matrix of B_A-type" refers to a host matrix wherein refractive indices $n_{x,h}$, $n_{y,h}$, and $n_{z.h}$ obey the following condition in the visible spectral range: $n_{y,h} > n_{z,h} > n_{x,h}$ or $n_{x,h} > n_{z,h} > n_{y,h}$

[0039] The term "anisotropic host matrix of positive A-type" refers to a host matrix, wherein refractive indices $n_{x,h}$, $n_{y,h}$, and $n_{z.h}$ obey the following condition in the visible spectral range: $n_{z,h} = n_{x,h} < n_{y,h}$ or $n_{z,h} = n_{y,h} < n_{x,h}$

[0040] The term "anisotropic host matrix of negative A-type" refers to a host matrix, wherein refractive indices $n_{x,h}$, $n_{y,h}$, and $n_{z.h}$ obey the following condition in the visible spectral range: $n_{z,h} = n_{y,h} > n_{x,h}$ or $n_{z,h} = n_{x,h} > n_{y,h}$.

[0041] The term "anisotropic host matrix of A_C-type" refers to a host matrix, wherein refractive indices $n_{x,h}$, $n_{y,h}$, and

$n_{z.h}$ obey the following condition in the visible spectral range: $n_{y,h} > n_{x,n} > n_{z,h}$.or $n_{x,h} > n_{y,h} > n_{z,h}$ (for positive A_C-type) and $n_{y,h} < n_{x,h} < n_{z,h}$.or $n_{x,h} < n_{y,h} < n_{z,h}$ (for negative A_C type)

[0042] The term "anisotropic host matrix of positive C-type" refers to a host matrix, wherein refractive indices $n_{x,h}$, $n_{y,h}$, and $n_{z.h}$ obey the following condition in the visible spectral range: $n_{x,h} = n_{y,h} < n_{z,h}$

[0043] The term "anisotropic host matrix of negative C-type" refers to a host matrix, wherein refractive indices $n_{x,h}$, $n_{y,h}$, and $n_{z.h}$ obey the following condition in the visible spectral range: $n_{x,h} = n_{y,h} > n_{z,h}$

[0044] The above mentioned definitions are invariant to rotation of system of coordinates (of the laboratory frame) for 90 degrees around of the vertical 0z-axis for all the types of the anisotropic host matrix.

[0045] The present invention provides an optically anisotropic compensation panel comprising at least one optically anisotropic layer on a substrate, the compensation panel possessing a spectrally controlled dispersion of refactive indices, wherein the the layer is based on an ordered guest-host system comprising an ordered anisotropic host matrix comprising an organic compound transparent to electromagnetic radiation in the visible spectral range, and having three principal refractive indices ($n_{x,h}$, $n_{y,h}$ and $n_{z,h}$) possessing a normal spectral dispersion $\partial\Delta_u(\lambda)/ \partial\lambda < 0$ in the visible spectral range, wherein the subscript u is selected from the list comprising x, y and z; and an ordered guest component comprising guest particles, the guest particles being optically anisotropic dye molecules that provide an absorption additional to an absorption of the anisotropic host matrix, realized in at least one principal direction of the anisotropic host matrix in at least one subrange of visible spectral range; such that the optically anisotropic layer has three principal refractive indices (n_x, n_y and n_z), at least one of which satisfies the following condition where $\partial n_u(\lambda)/ \partial\lambda \geq 0$ in at least one subrange of the visible spectral range, and wherein the subscript u is selected from the list comprising x, y and z.

[0046] The anisotropic host matrix may have further properties selected from:

a) biaxial properties of B_A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$ and/or out-of-plane difference of refractive indices $\Delta_{out,h} (\lambda) = | n_{x.h}(\lambda) - n_{z,n}(\lambda) |$;

b) uniaxial properties of positive A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$;

c) uniaxial properties of negative A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$;

d) biaxial properties of A_C-type having an in-plane difference of refractive indices $A_{in,h}(\lambda)= | n_{y,h}(\lambda)- n_{x.h}(\lambda) |$ and/or out-of-plane difference of refractive indices $\Delta_{out,h} (\lambda) = | n_{x.h}(\lambda) - n_{z,h}(\lambda) |$;

e) uniaxial properties of positive C-type having an out-of-plane difference of refractive indices $\Delta_{out,h} (\lambda) = | n_{x.h}(\lambda) - n_{z,h}(\lambda) |$; and

f) uniaxial properties of negative C-type having an out-of-plane difference of refractive indices $\Delta_{out,h} (\lambda) = | n_{x.h}(\lambda) - n_{z,h}(\lambda) |$;

wherein for each of b) to f) condition $\partial\Delta_{out,h} (\lambda)/\partial\lambda <0$ and/or condition $(\partial\Delta_{in,h}(\lambda)/\partial\lambda <0$ are satisfied in the visible spectral range.

[0047] In one embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses biaxial properties of B_A-type. This optically anisotropic layer is characterized by an in-plane difference of refractive indices $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\Delta \geq 0$ in at least one wavelength subrange of the visible spectral range. In this embodiment, the optically anisotropic layer may be further characterized by an out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_z(\lambda) - n_x(\lambda) |$ which satisfies the condition $\Delta_{out}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

[0048] In still another embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses biaxial properties of B_A-type. This optically anisotropic layer is characterized by an out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_z(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{out}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

[0049] In yet another embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses uniaxial properties of negative A-type. This optically anisotropic layer is characterized by an in-plane difference of refractive indices $\Delta_{in}(\lambda)= | n_y(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

[0050] In one embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses uniaxial properties of positive A-type. This optically anisotropic layer is characterized by an in-plane difference of refractive indices $\Delta_{in}(\lambda)= | n_y(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

[0051] In another embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses biaxial properties of A_C-type. This optically anisotropic layer is characterized by an in-plane difference of refractive indices $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range. In this embodiment, the optically anisotropic layer may be further characterized by an out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_x(\lambda) - n_z(\lambda) |$ which satisfies the condition $\Delta_{out}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

[0052] In still another embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses biaxial properties of A_C -type. This optically anisotropic layer is characterized by an out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_x(\lambda) - n_z(\lambda) |$ which satisfies the condition $\Delta_{out}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

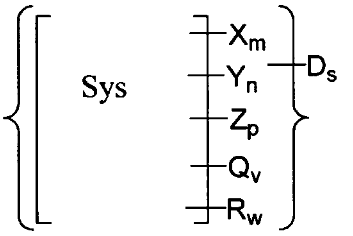
[0053] In yet another embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses uniaxial properties of negative C-type. This optically anisotropic layer is characterized by an out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_x(\lambda) - n_z(\lambda) |$ which satisfies the condition $\Delta_{out}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

[0054] In one embodiment of the disclosed optically anisotropic compensation panel, the optically anisotropic layer possesses uniaxial properties of positive C-type. This optically anisotropic layer is characterized by an out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_z(\lambda) - n_x(\lambda) |$ which satisfies the condition $\Delta_{out}(\lambda)/\partial\lambda \geq 0$ in at least one wavelength subrange of the visible spectral range.

[0055] In another embodiment of the disclosed optically anisotropic compensation panel, the in-plane difference of refractive indices $\Delta_{in}(\lambda)$ obeys the following condition: spectral dispersion factors $(\Delta_{in,450}/\Delta_{in,550})$ and $(\Delta_{in,550}/\Delta_{in,650})$ are in a range of 0.4 - 1.0, wherein $\Delta_{in,450}$, $\Delta_{in,550}$ and $\Delta_{in,650}$ are values of the in-plain differences of refractive indices at wavelengths of 450 nm, 550 nm and 650 nm respectively.

[0056] In still another embodiment of the disclosed optically anisotropic compensation panel, the out-of-plane difference of refractive indices $\Delta_{out}(\lambda)$ obeys the following condition: spectral dispersion factors $(\Delta_{out,450}/ \Delta_{out,550})$ and $(\Delta_{out,550}/ \Delta_{out,650})$ are in a range of 0.4 - 1.0, wherein $\Delta_{out,450}$, $\Delta_{out,550}$ and $\Delta_{out,650}$ are values of the out-of-plane difference of refractive indices $A_{out}(\lambda)$ at wavelengths of 450 nm, 550 nm and 650 nm respectively.

[0057] In one embodiment of the disclosed optically anisotropic compensation panel, the organic compound for the host matrix has a general structural formula I

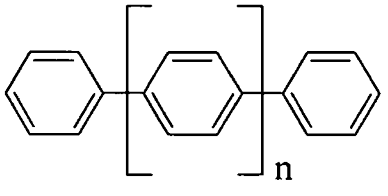
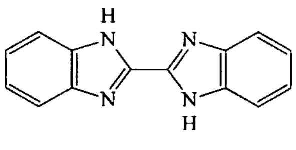


$$\left\{\left[\mathrm{Sys}\begin{array}{l} -X_m \\ -Y_n \\ -Z_p \\ -Q_v \\ -R_w \end{array}\right] -D_s\right\} \quad \text{(I)}$$

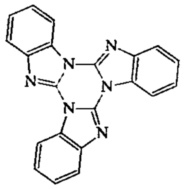
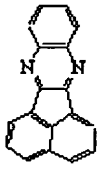
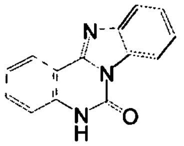
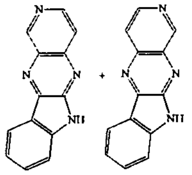
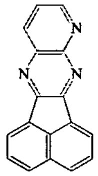
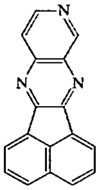
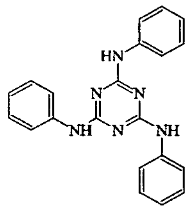
(I)

where Sys is an at least partially conjugated substantially planar polycyclic molecular system, X is a carboxylic group -COOH, *m* is 0, 1, 2, 3 or 4; Y is a sulfonic group $-SO_3H$, *n* is 0, 1, 2, 3 or 4; Z is a carboxamide, *p* is 0, 1, 2, 3 or 4; Q is a sulfonamide, v is 0, 1, 2, 3 or 4; D is a counterion; *s* is the number of counterions providing electrically neutral state of the molecule; R is a substituent selected from the list comprising CH_3, C_2H_5, Cl, Br, NO_2, F, CF_3, CN, OH, OCH_3, OC_2H_5, $OCOCH_3$, OCN, SCN, NH_2, and $NHCOCH_3$, and w is 0, 1, 2, 3 or 4. The polycyclic molecular system Sys has a general structural formula from the list comprising structures II to XLVI shown in the Table 1.

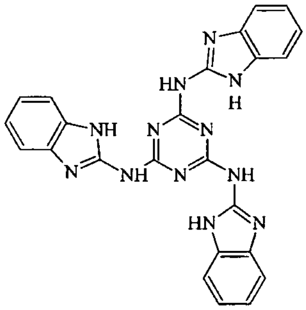
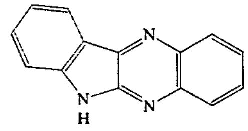
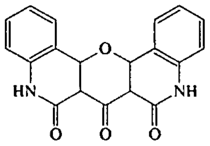
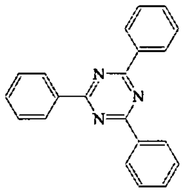
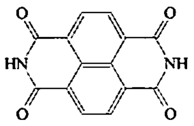
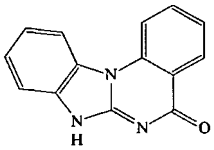
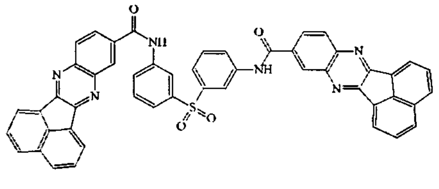
Table 1. Examples of polycyclic molecular systems (Sys)

 where n is a number in the range from 1 to 8 Oligophenyls	(II)
 1H,1'H-2,2'-bibenzimidazole	(III)

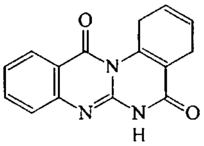
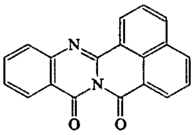
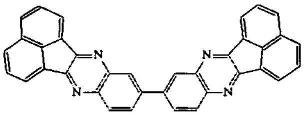
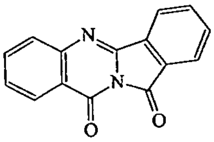
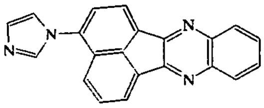
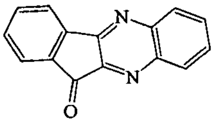
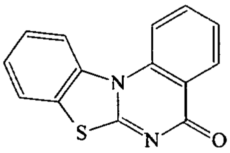
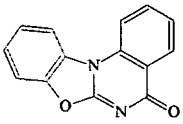
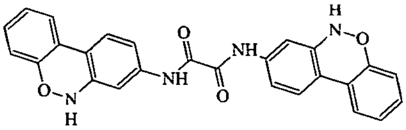
(continued)

 bisbenzimidazo[1’,2’:3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole	(IV)
 acenaphtho[1,2-b]quinoxaline	(V)
 benzimidazo[1,2-c]quinazolin-6(5H)-one	(VI)
 6H-pyrido[3’,4’:5,6]pyrazino[2,3-b]indole & 10H-pyrido[4’,3’:5,6]pyrazino[2,3-b]indole	(VII)
 acenaphtho[1,2-b]pyrido[2,3-e]pyrazine	(VIII)
 acenaphtho[1,2-b]pyrido[3,4-e]pyrazine	(IX)
 N,N’,N"-triphenyl-1,3, 5-triazine-2,4,6-triamine	(X)

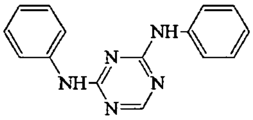
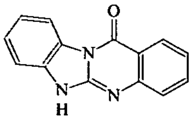
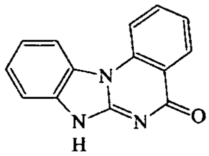
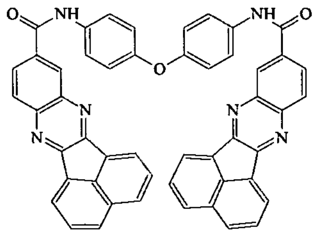
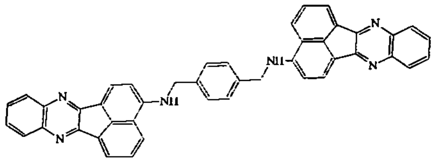
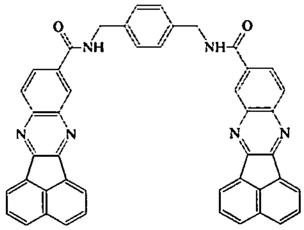
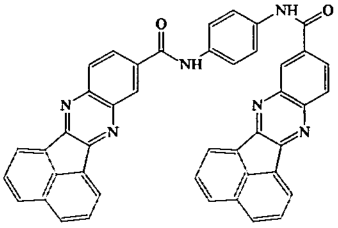
(continued)

 N,N',N"-tris(1H-benzimidazol-2-yl)-1,3,5-triazine-2,4,6-triamine	(XI)
 6H-indolo[2,3-b]quinoxaline	(XII)
 3,4,6,7-Dibenzo-4a,5a,9a,10a-tetrahydro-1H-pyrido[3',4':5,6]pyrano[3,2-c]pyridine-1,9,10(2H,8H)-trione	(XIII)
 2,4,6-triphenyl-1,3,5-triazine	(XIV)
 benzo[lmn]-3,8-phenanthroline-1,3,6,8(2H,7H)-tetrone	(XV)
 benzimidazo[1,2-a]quinazolin-5(7H)-one	(XVI)
 N,N'-[sulfonylbis(3,1-phenylene)]bisacenaphtho[1,2-b]quinoxaline-9-carboxamide	(XVII)

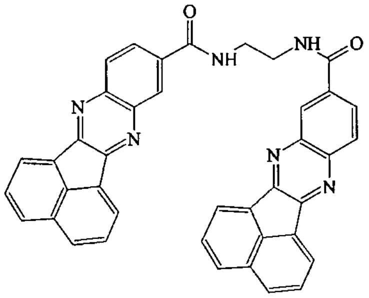
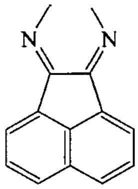
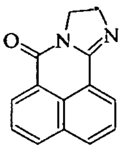
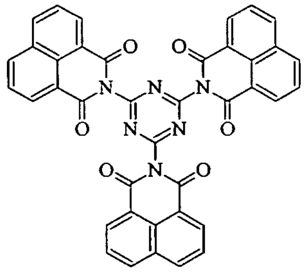
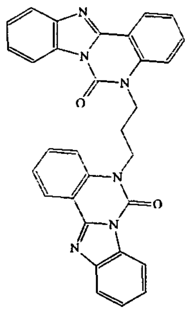
(continued)

 4H-quinazolino[3,2-a]quinazoline-5,12(1H,6H)-dione	(XVIII)
 7H,9H-benzo[4,5]isoquino[1,2-b]quinazoline-7,9-dione	(XIX)
 7H,9H-benzo[4,5]isoquino[1,2-b]quinazoline-7,9-dione	(XX)
 isoindolo[1,2-b]quinazoline-10,12-dione	(XXI)
	(XXII)
3-(1H-imidazol-1-yl)acenaphtho[1,2-b]quinoxaline	
 1H-indeno[1,2-b]quinoxalin-11-one	(XXIII)
 5H-[1,3]benzothiazolo[3,2-a]quinazolin-5-one	(XXIV)
 5H-[1,3]benzoxazolo[3,2-a]quinazolin-5-one	(XXV)
 N,N',-di-6H-dibenzo[c,e][1,2]oxazin-8-ylethanediamide	(XXVI)

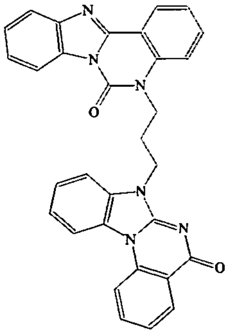
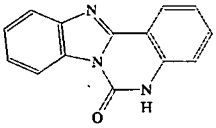
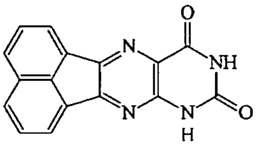
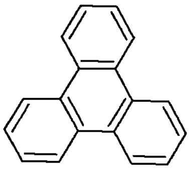
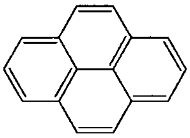
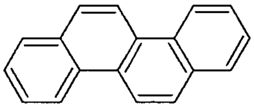
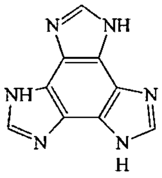
(continued)

 N,N'-diphenyl-1,3,5-triazine-2,4-diamine	(XXVII)
 benzimidazo[2,1-b]quinazolin-12(6H)-one	(XXVIII)
	(XXIX)
benzimidazo[1,2-a]quinazolin-5(7H)-one	
 N,N'-[oxybis(4,1-phenylene)]bisacenaphtho[1,2-b]quinoxaline-9-carboxamide	(XXX)
 N,N'-[1,4-phenylenedi(methylene)]bisacenaphtho[1,2-b]quinoxalin-3-amine	(XXXI)
 N,N'-[1,4-phenylenedi(methylene)]bisacenaphtho[1,2-b]quinoxaline-9-carboxamide	(XXXII)
 N,N'-1,4-phenylenebisacenaphtho[1,2-b]quinoxaline-9-carboxamide	(XXXIII)

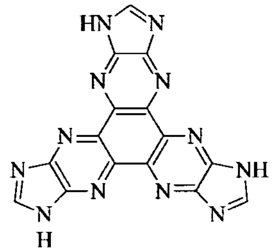
(continued)

 N,N'-ethane-1,2-diylbisacenaphtho[1,2-b]quinoxaline-9-carboxamide	(XXXIV)
 8,9-dihydroacenaphtho[1,2-b]pyrazine	(XXXV)
 9,10-dihydro-7H-benzo[de]imidazo[2,1-a]isoquinolin-7-one	(XXXVI)
 2,2',2"-(1,3,5-triazine-2,4,6-triyl)tris(1H-benzo[de]isoquinoline-1,3(2H)-dione)	(XXXVII)
 5,5'-propane-1,3-diylbisbenzimidazo[1,2-c]quinazolin-6(5H)-one	(XXXVIII)

(continued)

 5-[3-(5-oxobenzimidazo[1,2-a]quinazolin-7(5H)-yl)propyl]benzimidazo[1,2-c]quinazolin-6(5H)-one	(XXXIX)
 benzimidazo[1,2-c]quinazolin-6(5H)-one	(XL)
 acenaphtho[1,2-g]pteridine-9,11(8H,10H)-dione	(XLI)
 triphenylene	(XLII)
 pyrene	(XLIII)
 chrysene	(XLIV)
 Tris(imidazole)	(XLV)

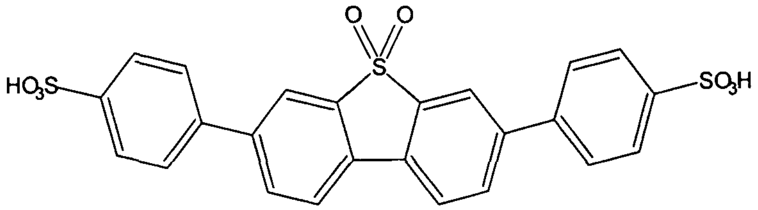
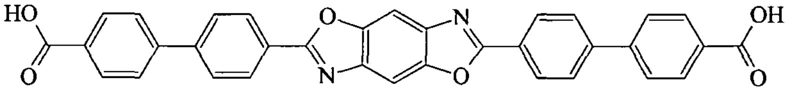
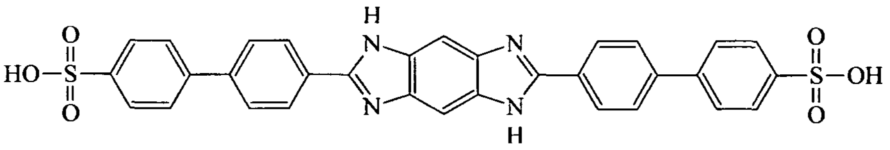
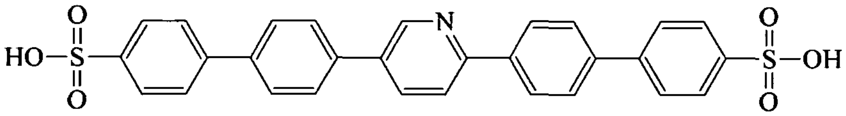
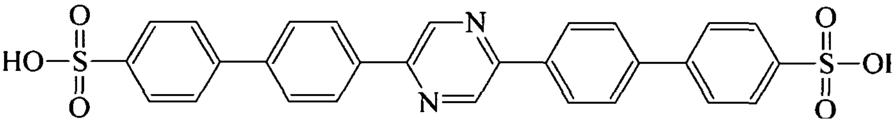
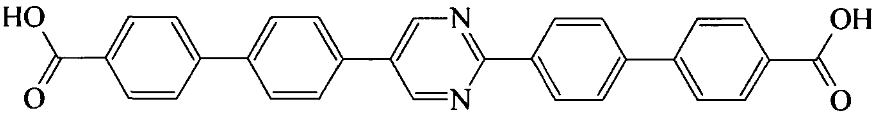
(continued)

 6,11-dihydro-1H-imidazo[4,5-b]bisimidazo[4’,5’:5,6]pyrazino[2,3-f:2’,3’-h]quinoxaline	(XLVI)

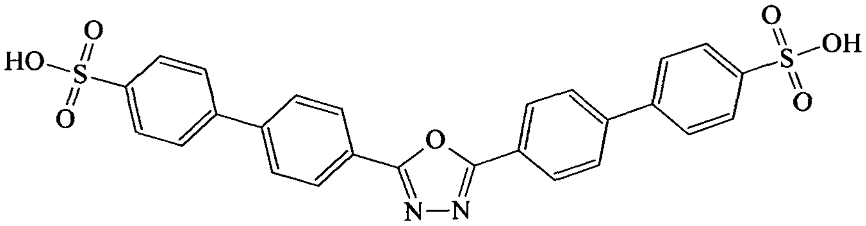
[0058] In yet another embodiment of the disclosed optically anisotropic compensation panel, the counterion is selected from the list comprising H^+, NH_4^+, Na^+, K^+, Li^+, Ba^{++}, Ca^{++}, Mg^{++}, Sr^{++}, Cs^+, Pb^{++}, and Zn^{++}.

[0059] In one embodiment of the disclosed optically anisotropic compensation panel, the organic compound is an oligophenyl derivative. The examples of the oligophenyl derivative of a general structural formula corresponding to structures 1 to 7 are given in Table 2.

Table 2. Examples of the structural formulas of oligophenyl derivative

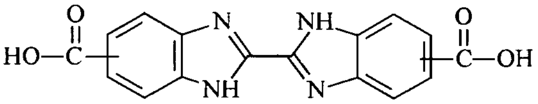
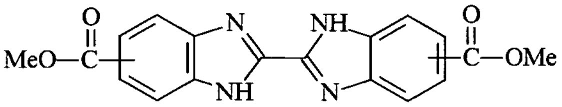
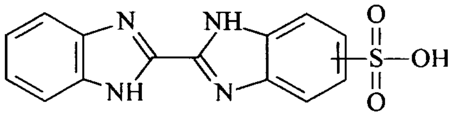
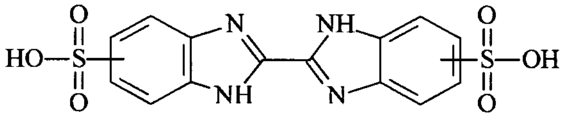
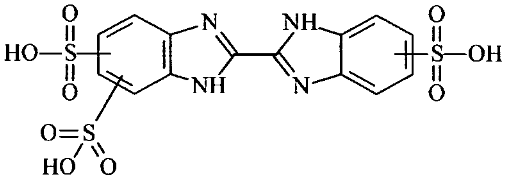
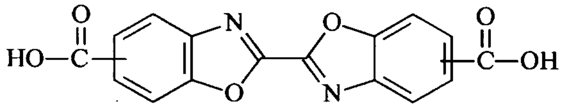
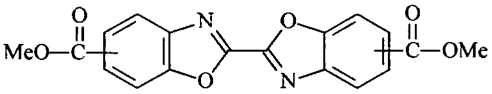
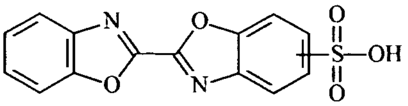
 4,4’-(5,5-dioxidodibenzo[b,d]thiene-3,7-diyl)dibenzenesulfonic	(1)
 4,4"-[1,3]oxazolo[5,4-f][1,3]benzoxazole-2,6-diyldibiphenylsulfonic acid	(2)
 4,4"-(1,5-dihydroimidazo[4,5-f]benzimidazole-2,6-diyl)dibiphenylsulfonic acid	(3)
 4’,4"-pyridine-2,5-diyldibiphenyl-4-sulfonic acid	(4)
 4’,4"-pyrazine-2,5-diyldibiphenyl-4-sulfonic acid	(5)
 4’,4"-pyrimidine-2,5-diyldibiphenyl-4-carboxylic acid	(6)

(continued)

 4',4"-(1,3,4-oxadiazole-2,5-diyl)dibiphenyl-4-sulfonic acid	(7)

[0060] In another embodiment of the disclosed optically anisotropic compensation panel, the organic compound is selected from the list comprising derivatives of 1H,1'H-2,2'-bibenzimidazole, derivatives of 2,2'-bi-1,3-benzoxazole, and derivatives of 2,2'-bi-1,3-benzothiazole. In yet another embodiment of the present invention, the organic compound has general structural formulas shown in Table 3.

Table 3. Examples of 2,2'-bibenzheteroazole derivatives

	(8)
	(9)
	(10)
	(11)
	(12)
	(13)
	(14)
	(15)

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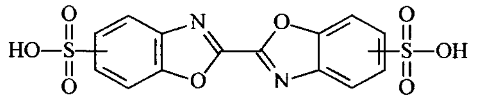
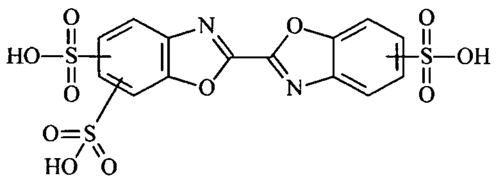
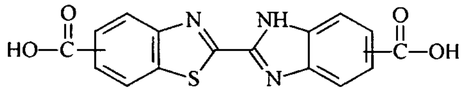
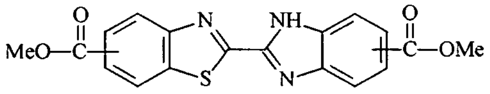
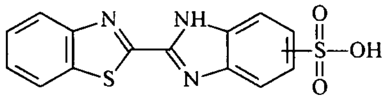
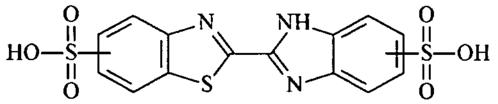
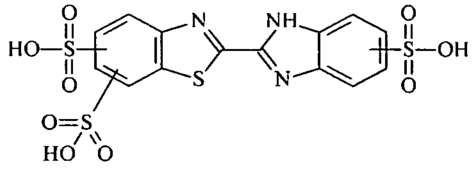
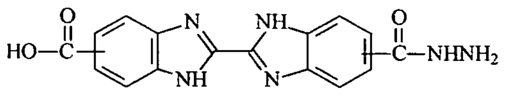
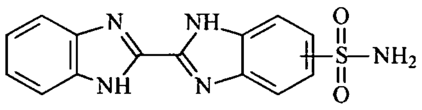
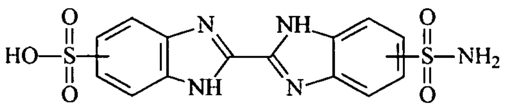
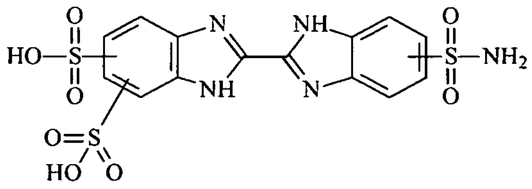
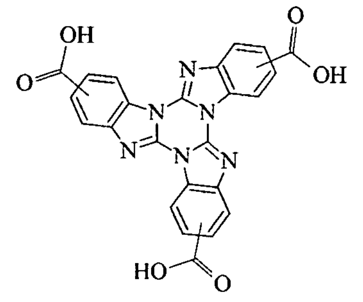
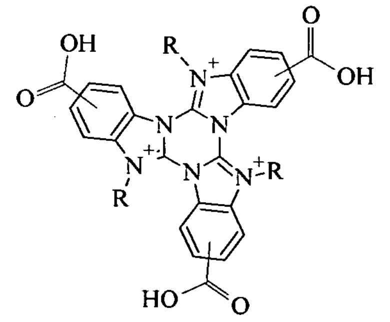
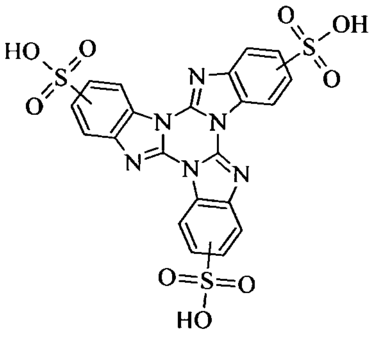
	(16)
	(17)
	(18)
	(19)
	(20)
	(21)
	(22)
	(23)
	(24)
	(25)
	(26)

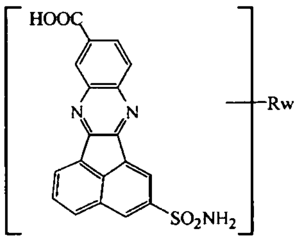
[0061] In still another embodiment of the disclosed optically anisotropic compensation panel, the organic compound has a general structural formula corresponding to one of structures 27 to 29 shown in Table 4.

Table 4. Examples of the structural formulas.

	(27)
 R= CH_3, C_2H_5, C_3H_7, C_4H_9	(28)
	(29)

[0062] In one preferred embodiment of the disclosed compensation panel, the organic compound is acenaphthoquinoxaline derivative comprising a carboxylic group. Examples of the acenaphthoquinoxaline derivative comprising carboxylic and/or sulfonic groups and having general structural formulas corresponding to structures 30-48 are given in Table 5.

Table 5. Examples of the structural formulas of acenaphthoquinoxaline derivative

	(30)

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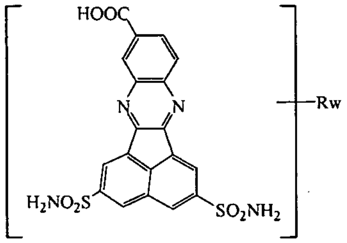
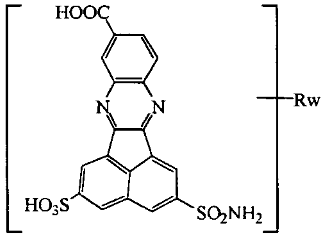
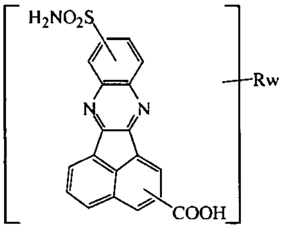
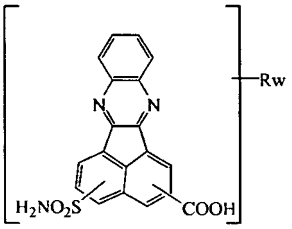
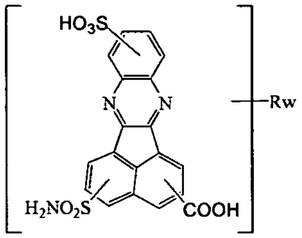
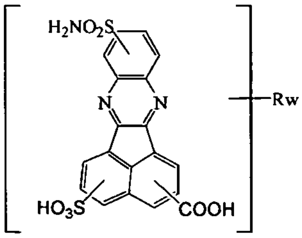
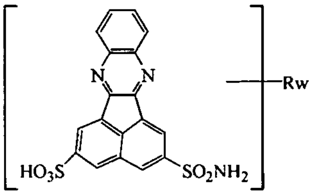
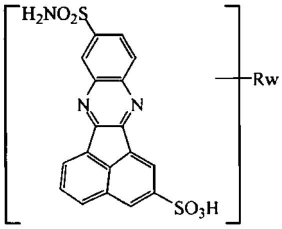
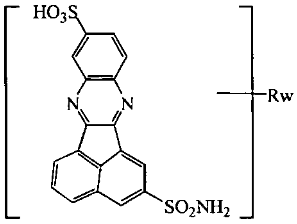
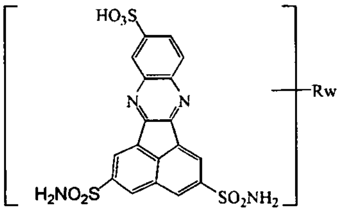
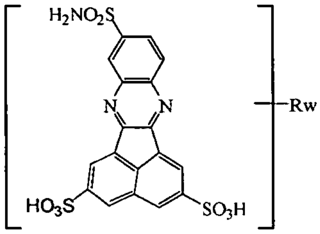
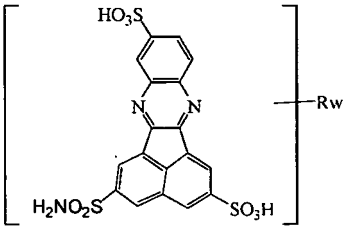
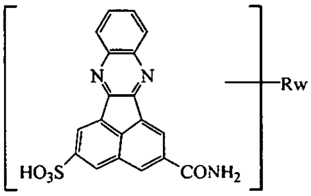
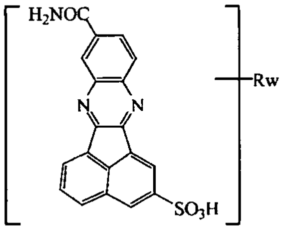
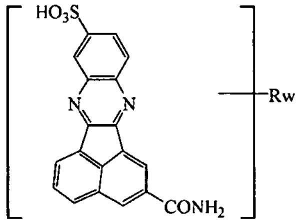
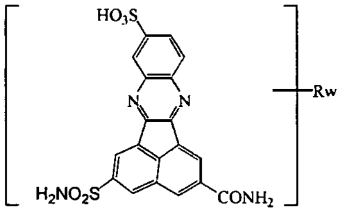
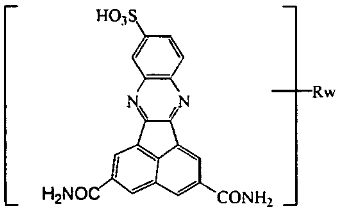
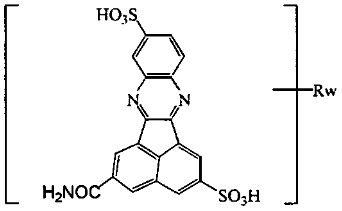
	(31)
	(32)
	(33)
	(34)
	(35)
	(36)

(continued)

	(37)
	(38)
	(39)
	(40)
	(41)
	(42)
	(43)

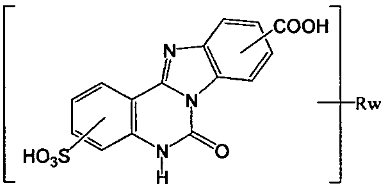
(continued)

	(44)
	(45)
	(46)
	(47)
	(48)

[0063] In yet another preferred embodiment of the disclosed compensation panel, the organic compound is a 6,7-dihydrobenzimidazo[1,2-c]quinazolin-6-one derivative.

[0064] In one embodiment the 6,7-dihydrobenzimidazo[1,2-c]quinazolin-6-one derivative comprises carboxylic and/or sulfonic groups and has a general structural formula from the group comprising structures 49 to 70. The examples are given in Table 6.

Table 6. Examples of the structural formulas of 6,7-dihydrobenzimidazo[1,2-c]quinazolin-6-one derivative

	(49)

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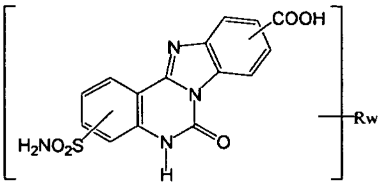
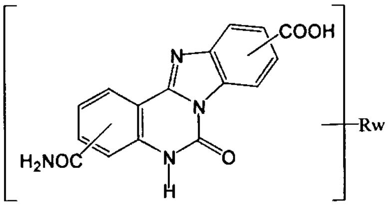
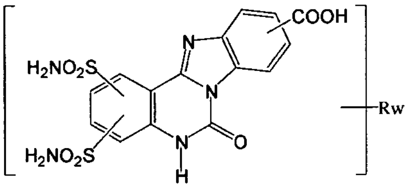
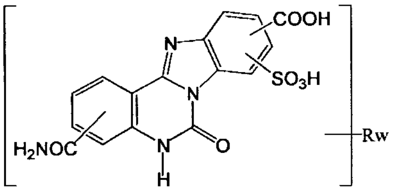
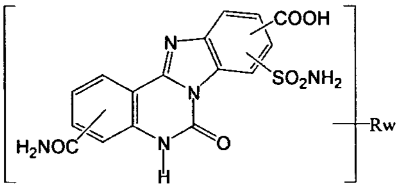
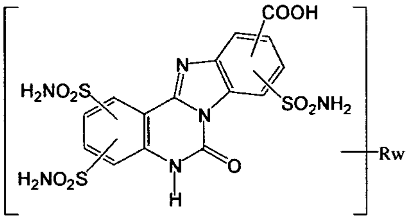
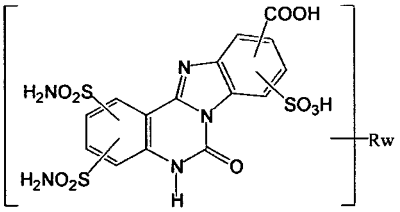
	(50)
	(51)
	(52)
	(53)
	(54)
	(55)
	(56)

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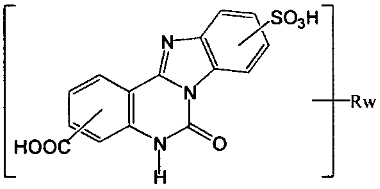
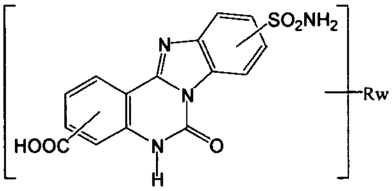
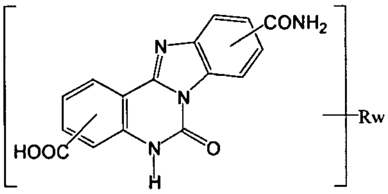
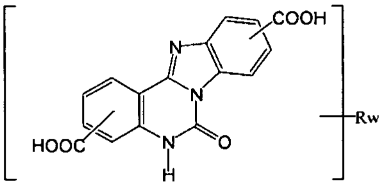
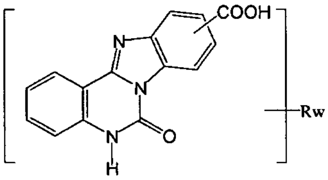
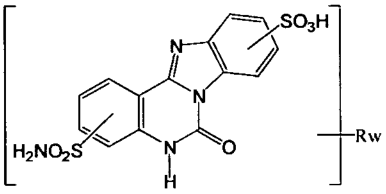
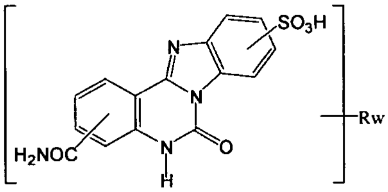
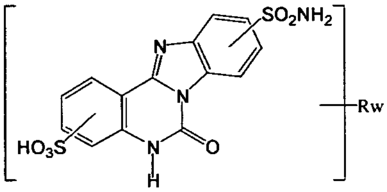
	(57)
	(58)
	(59)
	(60)
	(61)
	(62)
	(63)
	(64)

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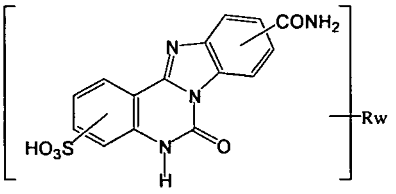
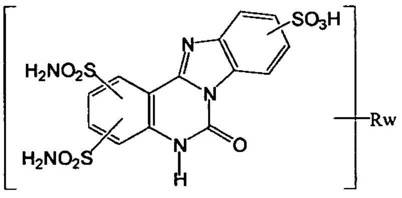
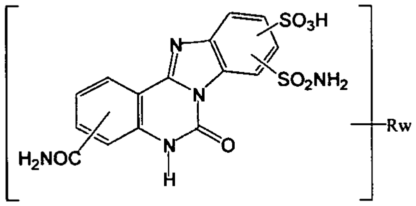
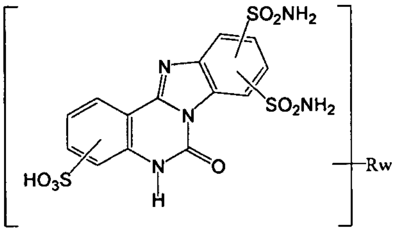
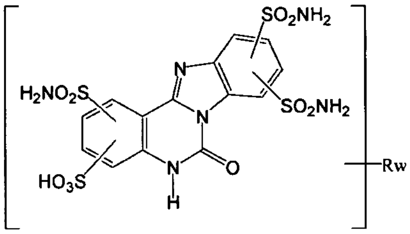
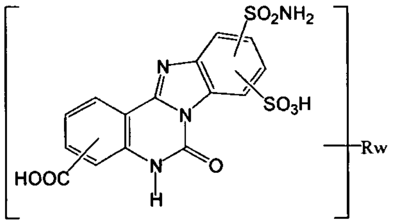
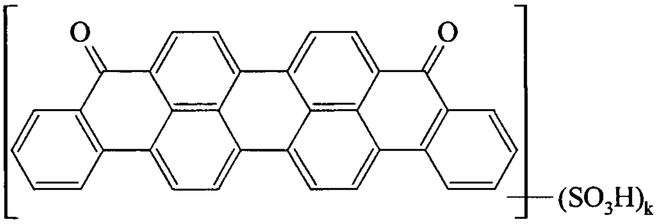
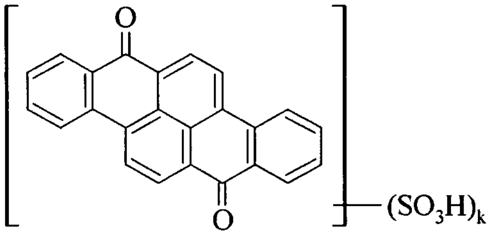
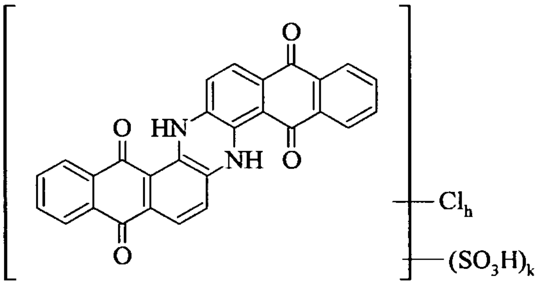
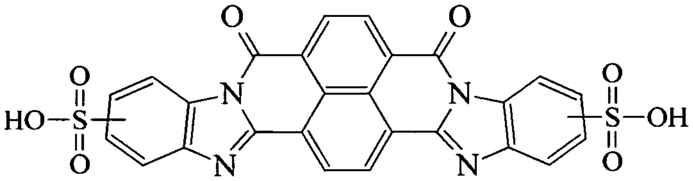
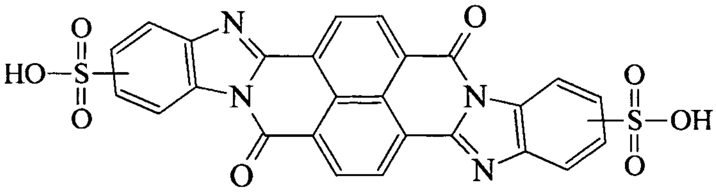
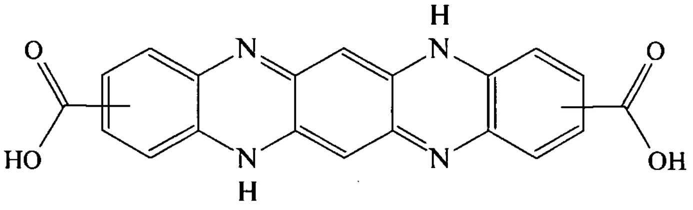
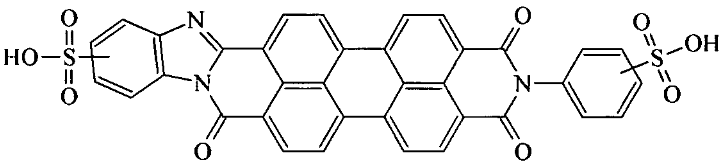
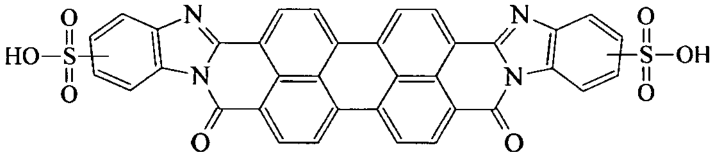
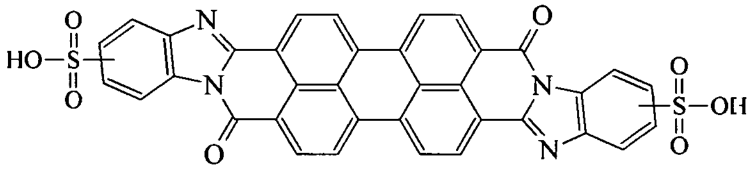
	(65)
	(66)
	(67)
	(68)
	(69)
	(70)

[0065] The anisotropic host matrix may comprise uniaxial anisotropic supramolecules which are oriented with one of their principal axes substantially parallel to the x-axis. For this embodiment one of principal directions of polarizability tensor coincides with the principal axis of said supramolecules. Other two principal axes may be chosen in a perpendicular plane arbitrarily and principal values of the polarizability tensor along these chosen two principal axes are substantially equal. The guest absorbing particles are optically anisotropic dye molecules. In a preferred embodiment of the disclosed compensation panel, the guest particles have a general structural formula corresponding to structures 71 to 79 shown in Table 7.

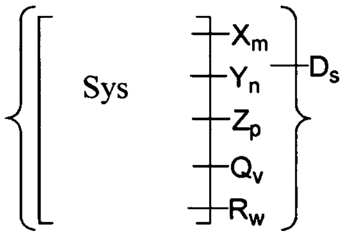
Table 7. Examples of the structural formulas

 k=1,2,3,4	(71)
 k=1,2,3,4	(72)
 h=0,l k=1,2,3,4	(73)
	(74)
	(75)
	(76)
	(77)

(continued)

	(78)
	(79)

[0066] In one embodiment of the present invention, the optically anisotropic compensation panel further comprises a substrate made of one or several materials of the group comprising diamond, quartz, plastics, glasses, ceramics, and comprises at least one element of the group comprising color filter substrate, circuit features, multilevel interconnects, and thin film transistor (TFT) array substrate.



[0067] The dispersion of refractive indexes can be evaluated using the known Kramers-Kronig relation. The Kramers-Kronig (KK) relation is one of fundamental principles. It puts restrictions on response functions of the physical systems being in an equilibrium state. The KK relation is based on a causality principle, when the current event can not influence on an event in the past. The last makes the Fourier component of the response to be the analytical function in the positive half-plane of the complex frequency and leads to relations between its real and imaginary parts. The generality of the KK principle is in that it does not need any assumptions regarding the structure of a system or media. In the present case, the real part of the refractive index can be expressed in terms of the absorption coefficient (imaginary part) as follows:

$$n(\omega) = 1 + \frac{2}{\pi} P \int_0^\infty \frac{x\alpha(x)}{x^2 - \omega^2} dx, \qquad (78)$$

[0068] Symbol P means that the integral should be calculated in a sense of its main value. The formula (78) is a generalized formula of the Kramers-Kronig relation. In the optical applications each separate absorption band contributes into the value of refractive indices. In the optical spectral range the central frequencies of the absorption bands have values substantially higher than their widths. In this particular case one can easily simplify and calculate the individual band contributions in the integral (78), so the local shape of the dispersion curve can be quite well approximated by a constant plus the integral over a finite spectral range of the closest absorption bands:

$$n(\omega) = n_o + \frac{2}{\pi} P \int_{\omega 1}^{\omega 2} \frac{x\alpha(x)}{x^2 - \omega^2} dx. \qquad (79)$$

[0069] The value n_0 can be found if the refractive index is measured somewhere in the range (ω_1, ω_2), for instance, where the absorption is small. Namely no value contains the contributions from the integrals outside of the spectral range of (ω_1, ω_2). The spectral dependence of the absorption coefficient *a(x)* in (79) can also be extracted from the experimental data.

[0070] The KK relation for the absorption coefficient is:

$$\alpha(\omega) = -\frac{2\omega}{\pi} P\int_0^\infty \frac{n(x)}{x^2-\omega^2}dx \qquad (80)$$

[0071] The complex refractive index is defined as:

$$n(\omega) = n(\omega) - i\alpha(\omega) \qquad (81)$$

[0072] The $\alpha(\omega)$ is an imaginary part and has no dimension. In practice it is convenient to use another definition of the absorption coefficient (more accurately absorption index), which is defined as

$$k(\omega) = -\frac{2\omega}{c}\alpha(\omega), \qquad (82)$$

where c is light velocity, and the absorption index has a dimension of inverse length. The value *k(ω)* is used in a well-known Bouguer-Lambert law, which shows the attenuation of the light intensity I in absorbing media:

$$I = I_0 \exp(-k(\omega)l) \qquad (83)$$

[0073] Replacing the frequency variable ω by wavelength λ the equations1 and 2 can be rewritten as:

$$n(\lambda) = 1 + \frac{1}{2\pi^2} P\int_0^\infty \frac{k(y)}{1-\left(\frac{y}{\lambda}\right)^2}dy. \qquad (84)$$

$$n(\lambda) = n_0 + \frac{1}{2\pi^2} P\int_{\lambda_1}^{\lambda_2} \frac{k(y)}{1-\left(\frac{y}{\lambda}\right)^2}dy. \qquad (85)$$

[0074] For the derivation of formulas (84) and (85) we used the following replacements, $\omega=2\pi c/\lambda$ and $x=2\pi c/y$. The equation (84) is useful for the experimental data when an absorption index spectrum is measured versus wavelength.

[0075] The present invention also provides the color liquid crystal display comprising a liquid crystal cell, first and second polarizers arranged on each side of the liquid crystal cell, and at least one compensation panel, according to the present invention, located between said polarizers.

[0076] In one embodiment of the disclosed display, the liquid crystal cell is an in-plane switching mode liquid crystal cell. In another embodiment of the disclosed display, the liquid crystal cell is a vertically-aligned mode liquid crystal cell. In still another embodiment of the disclosed display, the compensation panel is located inside the liquid crystal cell. In yet another embodiment of the disclosed display, the compensation panel is located outside the liquid crystal cell.

[0077] A more complete assessment of the present invention and its advantages will be readily achieved as the same becomes better understood by reference to the following detailed description, considered in connection with the accompanying drawings and detailed specification, all of which forms a part of the disclosure.

[0078] Figure 6 schematically shows a light beam 10 and a color liquid crystal display according to the present invention which comprises a liquid crystal cell 1, a pair of polarizers 12 and 20, arranged on each side of the liquid crystal cell, and two compensating panels 13 and 17, disposed between the liquid crystal cell and the first polarizer 12, and the liquid crystal cell and the second polarizer 20, consequently. The liquid crystal cell is schematically shown in Figure 5. In one embodiment of the disclosed display, the liquid crystal cell is an in-plane switching mode liquid crystal cell. In another embodiment of the disclosed display, the liquid crystal cell is a vertically-aligned mode liquid crystal cell. The transmission axis 21 of the first polarizer is perpendicular to the transmission axis 28 of the second polarizer. The first compensation panel 13 comprises an anisotropic layer of the first type 14, having slow 22 and fast 23 principal axes (the principal axes correspond to the principal axes of the dielectric tensor) lying substantially in the plane of said anisotropic layer 14, and an anisotropic layer of the second type 15, as a negative C-panel with the optical axis 24 directed substantially perpendicularly to the plane of said anisotropic layer 15. The anisotropic layer 14 is arranged in such a way that the fast principal axis 23, corresponding to lowest dielectric permittivity, of said anisotropic layer is perpendicular to the transmission axis 21 of the polarizer 12. The anisotropic layer 14 is an uniaxial anisotropic layer of negative A-type and it is characterized by three principal refractive indices (n_x, n_y and n_z) and an in-plane difference of refractive indices $\Delta_{in}(\lambda)= | n_y(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in the visible spectral range. Two principal directions for refractive indices n_x and n_y belong to xy-plane, one refractive index (n_z) corresponds to the normal direction, and the refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_z = n_x > n_y$.

[0079] In still another embodiment of the disclosed display, the anisotropic layer of the second type 15 is an optically anisotropic layer possessing uniaxial properties of negative C-type and it is characterized by three principal refractive indices (n_x, n_y and n_z) and the out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_x(\lambda) - n_z(\lambda) |$ which satisfies the condition $\partial\Delta_{out}(\lambda)/\partial\lambda \geq 0$ in the visible spectral range. The refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_x = n_y > n_z$. The second compensation panel 17 comprises an anisotropic layer of the first type 19 having slow 27 and fast 26 principal axes lying substantially in the plane of said anisotropic layer 19, and an anisotropic layer of the second type 18 as a negative C-panel with the optical axis 25 directed substantially perpendicularly to the plane of said anisotropic layer 18. The retardation layer of the first type 19 is arranged in such a way that the fast principal axis 26 of said anisotropic layer is perpendicular to the transmission axis 28 of the polarizer 20. The anisotropic layer of the first type 19 is a layer of negative A-type and characterized by three principal refractive indices (n_x, n_y and n_z) and a difference of the in-plane difference of refractive indices $\Delta_{in}(\lambda)= | n_y(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in the visible spectral range. Two principal directions for refractive indices n_x and n_y belong to xy-plane, one refractive index (n_z) corresponds to the normal direction, and the refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_z = n_y > n_x$.

[0080] Thus in this embodiment of the color display, the compensation panels 13 and 17 are located outside the liquid crystal cell.

[0081] Figure 7 schematically shows another embodiment of the disclosed color liquid crystal display similar to the display shown in Figure 6. The liquid crystal cell is schematically shown in Figure 5. In one embodiment of the disclosed display, the liquid crystal cell is an in-plane switching mode liquid crystal cell. In another embodiment of the disclosed display, the liquid crystal cell is a vertically-aligned mode liquid crystal cell. The difference is in an orientation of principal axes (slow and fast) of the anisotropic layers of the first type - 14 and 19, respectively. The anisotropic layer 14 is arranged in such a way that the slow principal axis 22 of said anisotropic layer is perpendicular to the transmission axis 21 of the polarizer 12, and the anisotropic layer 19 is arranged in such a way that the slow principal axis 27 of said anisotropic layer is perpendicular to the transmission axis 28 of the polarizer 20. In this embodiment of the color display, the compensation panels 13 and 17 are located outside the liquid crystal cell.

[0082] Figure 8 schematically shows a light beam 10 and a liquid crystal display according to the present invention. The liquid crystal display comprises a liquid crystal cell 1, two polarizers - 12 and 20, arranged on each side of the liquid crystal cell, and one compensation panel 17 disposed between the liquid crystal cell and the second polarizer 20. The liquid crystal cell is schematically shown in Figure 5. In this embodiment of the color display, the compensation panel 17 is located outside the liquid crystal cell. In one embodiment of the disclosed display, the liquid crystal cell is an in-plane switching mode liquid crystal cell. In another embodiment of the disclosed display, the liquid crystal cell is a vertically-aligned mode liquid crystal cell. The compensation panel 17 comprises an anisotropic layer of the first type 19 having slow 27 and fast 26 axes lying substantially in the layer plane, and an anisotropic layer of the second type 18 as a negative C-panel with the optical axis 25 directed substantially perpendicular to the layer plane. The anisotropic layer 19 is arranged such that the fast principal axis 26 of said anisotropic layer is perpendicular to the transmission axis 28 of the polarizer 20. The anisotropic layer of the first type 19 is a layer of negative A-type and characterized by three principal refractive indices (n_x, n_y and n_z) and a difference of the in-plane difference of refractive indices $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$ possessing anomalous spectral dispersion ($\partial\Delta_{in}(\lambda)/\partial\lambda > 0$) in the visible spectral range. Two principal directions for refractive indices n_x and n_y belong to xy-plane, one refractive index (n_z) corresponds to the normal direction, and the refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_z = n_y > n_x$.

[0083] Figure 9 schematically shows a light beam 10 and a liquid crystal display according to the present invention. The liquid crystal display comprises a liquid crystal cell 1, a pair of polarizers - 12 and 20, arranged on each side of the liquid crystal cell, and one compensation panel 13 disposed between the liquid crystal cell and the first polarizer 12. The liquid crystal cell 1 is schematically shown in Figure 5. In this embodiment of the display, the compensation panel 13 is located outside the liquid crystal cell. In one embodiment of the disclosed display, the liquid crystal cell is an in-plane switching mode liquid crystal cell. In another embodiment of the disclosed display, the liquid crystal cell is a vertically-aligned mode liquid crystal cell. The transmission axis (21) of the first polarizer is perpendicular to the transmission axis (28) of the second polarizer. The first compensation panel (13) comprises an anisotropic layer of the first type (14) having slow (22) and fast (23) axes lying substantially in the layer plane, and an anisotropic layer of the second type (15) as a negative C-panel with the optical axis (24) directed substantially perpendicular to the anisotropic layer plane. The anisotropic layer (14) is arranged such that the fast principal axis (23) of said anisotropic layer is perpendicular to the transmission axis (21) of the polarizer (12). The anisotropic layer (14) is a uniaxial anisotropic layer of negative A-type and characterized by three principal refractive indices (n_x, n_y and n_z) and the in-plane difference of refractive indices $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$ which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in the visible spectral range. Two principal directions for refractive indices n_x and n_y belong to xy-plane, one refractive index (n_z) corresponds to the normal direction, and the refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_z = n_x > n_y$.

[0084] Figure 10 schematically shows a light beam 10 and a color liquid crystal display according to the present invention. The liquid crystal display comprises a liquid crystal cell 1, a pair of polarizers - 12 and 20, arranged on each side of the liquid crystal cell, and one compensation panel 30 disposed between the liquid crystal cell and the first polarizer 12. The liquid crystal cell 1 is schematically shown in Figure 5. Thus in this embodiment of the display, the compensation panel 30 is located outside the liquid crystal cell. In one embodiment of the disclosed display, the liquid crystal cell is an in-plane switching mode liquid crystal cell. In another embodiment of the disclosed display, the liquid crystal cell is a vertically-aligned mode liquid crystal cell. The transmission axis 21 of the first polarizer is perpendicular to the transmission axis 28 of the second polarizer. The compensation panel 30 comprises at least one optically anisotropic layer possessing biaxial properties of B_A-type and characterized by 1) three principal refractive indices (n_x, n_y and n_z), 2) an in-plane difference of refractive indices $\Delta_{in}(\lambda)$ $| n_y(\lambda) - n_x(\lambda) |$ possessing anomalous spectral dispersion ($\partial\Delta_{in}(\lambda)/\partial\lambda > 0$) in the visible spectral range, and 3) an out-of-plane difference of the refractive indices in thickness direction $\Delta_{out}(\lambda) = | n_z(\lambda) - n_x(\lambda) |$ possessing anomalous spectral dispersion ($\partial\Delta_{out}(\lambda)/\partial\lambda > 0$) in the visible spectral range. Two principal directions for refractive indices n_x and n_y belong to xy-plane, one refractive index (n_z) corresponds to the normal direction, and the refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_x > n_z > n_y$. The anisotropic layer 35 is arranged such that the fast principal axis 45 of said anisotropic layer is perpendicular to the transmission axis 21 of the polarizer 12. For the biaxial anisotropic layer 35 all of the three principal refractive indices n_x, n_y, and n_z *are* different. In still another embodiment of the liquid crystal display, the compensation panel comprising at least one biaxial anisotropic layer may be disposed between the liquid crystal call and the second polarizer 20.

[0085] In yet another embodiment of the present invention, the liquid crystal display comprises two compensation panels. Each of the panels comprises at least one biaxial anisotropic layer and they are located on each side of the liquid crystal cell.

[0086] Another embodiment of the present invention is schematically shown in Figure 11. The IPS LCD - the liquid crystal display with the IPS-mode liquid crystal cell, comprises the first polarizer 55, the second polarizer 56, liquid crystal cell 57 situated between said first and second polarizers, the front substrate 58 with a color filter 59 (RGB - type), black matrix 60 and planarization layer 61, other functional layers 62 comprising electrode and alignment layers, the back substrate 63 with electrodes, driving elements and alignment layers. The compensation panel 64 is located between the liquid crystal layer 57 and the second polarizer 56. Thus in this embodiment of the disclosed color display, the compensation panel is located inside the liquid crystal cell. The first and second polarizers have absorption axes, which are perpendicular to each other. In another embodiment of the disclosed color display, the liquid crystal cell may be a vertically-aligned mode liquid crystal cell (VA LCD).

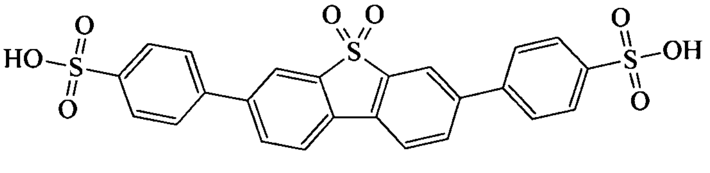
[0087] For the liquid crystal display designs with an RGB color filter one pixel comprises three subpixels of red, green and blue colors. In this case the compensation panel comprises at least one optically anisotropic layer possessing biaxial properties of B_A-type and characterized by 1) three principal refractive indices (n_x, n_y and n_z), 2) an in-plane difference of refractive indices $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$ possessing anomalous spectral dispersion ($\partial\Delta_{in}(\lambda)/\partial\lambda > 0$) in the visible spectral range, and 3) the out-of-plane difference of refractive indices $\Delta_{out}(\lambda) = | n_z(\lambda) - n_x(\lambda) |$ possessing anomalous spectral dispersion ($\partial\Delta_{out}(\lambda)/\partial\lambda > 0$) in the visible spectral range. Two principal directions for refractive indices n_x and n_y belong to xy-plane, one refractive index (n_z) corresponds to the normal direction, and the refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_x > n_z > n_y$.

[0088] In order that the invention may be more readily understood, reference is made to the following examples, which are intended to be illustrative of the invention, but are not intended to be limiting in scope.

EXAMPLES

Example 1

[0089] This example describes the preparation of polycyclic organic compound - Table 2, structural formula 1:

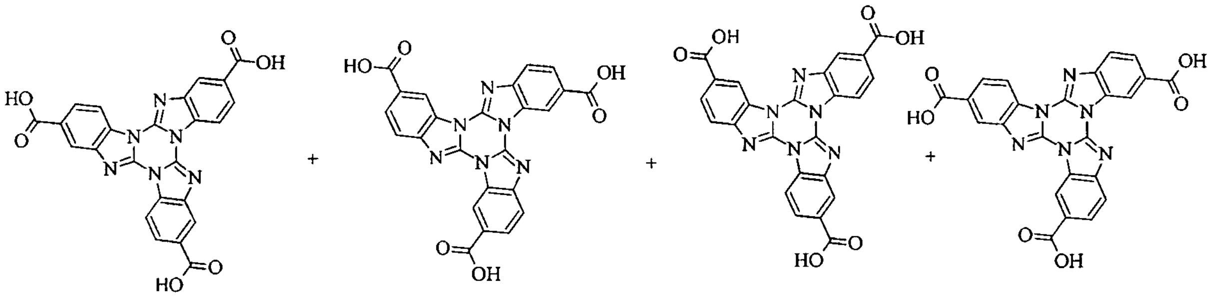


[0090] 4,4’-(5,5-Dioxidodibenzo[b,d]thiene-3,7-diyl)dibenzenesulfonic acid (II) was prepared by sulfonation of 1,1’:4’,1":4",1"’-quaterphenyl. 1,1’:4’,1":4",1"’-Quaterphenyl (10 g) was charged into 20% oleum (100 ml). Reaction mass was agitated for 5 hours at ambient conditions. After that the reaction mixture was diluted with water (170 ml). The final sulfuric acid concentration was around 55%. The precipitate was filtered and rinsed with glacial acetic acid (~200 ml). Filter cake was dried in oven at ~110°C. The process yielded 8 g of 4,4’-(5,5-Dioxidodibenzo[b,d]thiene-3,7-diyl)dibenzenesulfonic acid.

[0091] The product was analyzed with ^{1}H NMR (Brucker Avance-600, DMSO-d_6, δ, ppm) and showed the following results: 7.735 (d, 4H, 4CH^{Ar}(3,3’,5,5’)); 7.845 (d, 4H, 4CH^{Ar}(2,2’,6,6’)); 8.165 (dd, 2H, 2CH^{Ar}(2,8)); 8.34 (m, 4H, 4CH^{Ar}(1,9,4,6)). The electronic absorption spectrum of the product measured in an aqueous solution with Spectrometer UVNIS Varian Cary 500 Scan showed the absorption maxima at λ_{max1} =218 nm (ε=3.42*10^4), λ_{max2} = 259 nm (ε=3.89*10^4), and λ_{max3} = 314 nm (ε=4.20*10^4). Mass spectrum of the product recorded using a Brucker Daltonics Ultraflex TOF/TOF is as follows: molecular ion (M$^-$= 529), FW=528.57.

Example 2

[0092] The example describes synthesis of the mixture of bisbenzimidazo[1’,2’:3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole-tricarboxylic acids, the heterocyclic molecular system of which is presented in Table 4, structural formula 27:



A. 5-methyl-1,3-dihydro-2H-benzimidazol-2-one

[0093] 4-Methyl-1,2-phenylendiamine dihydrocloride (20.75 g, 106 mmol) was ground with urea (7.64 g, 127 mmol). The mixture was charged to a heat-resistant beaker and heated up to 150°C. After 1.5 hours reaction mixture was cooled to room temperature. The solid material was triturated and charged to heat-resistant beaker and it still was heated at 150°C for 1.5 hours. Then reaction mixture was dissolved in the boiling 1-1.5% aqueous solution of sodium hydroxide (1.5 L). Obtained solution was filtered from undissolved solid, boiled with activated black carbon (BAU-A, 2 g) for 20-30 min and filtered. Filtrate was acidified by concentrated hydrochloric acid till pH ~ 6. White precipitate was filtered, washed with water (100 ml) and dried in desiccator under phosphorous oxide in vacuo. Yield: 13.1 g (83.5%).

[0094] Methyl 2-oxo-2,3-dihydro-1H-benzimidazole-6-carboxylate (43 g, 0.22 mol) was charged into phosphorus oxychloride (286 ml). Dry hydrogen chloride was bubbled through the boiling reaction mass for 12 hours. After cooling reaction mass was poured in mixture of ice and water (2 kg). Precipitate was filtered out. Filtrate was diluted with water (1.25 litres) and ammonia solution (~800 ml). After that pH was adjusted to 5.6 with ammonia solution. Precipitate was filtered and rinsed with water. Yield 39.5 g (84%).

B. 2-chloro-6-methyl-1H-benzimidazole

[0095] 5-Methyl-1,3-dihydro-2H-benzimidazol-2-one (13.1 g, 88.5 mmol) and phosphorus oxychloride (130 ml, freshly distillated) was charged into three-neck round-bottom flask. The mixture was heated up to boiling point till homogeneous solution was formed. After that the dried hydrogen chloride was bubbled through inlet gas-pipe into the reaction mixture. The mixture was boiled for 15 hours. Excess of phosphorus oxychloride was distillated in vacuo. Mixture of ice and water (250 ml) was added to residue. The obtained suspension was cooled to the room temperature and filtered. Filtrate was alkalinized by aqueous ammonia solution till pH 8, cooled by cold water and filtered crude 2-chloro-6-methyl-1H-benzimidazole. White powder was crystallized from aqueous methanol (water-methanol: 1:1, 200 ml), washed by aqueous methanol and dried in a desiccator under phosphorous oxide in vacuo. Yield: 8.17 g (55 %).).

C. Trimethyl-bisbenzimidazo[1’,2’:3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazoles

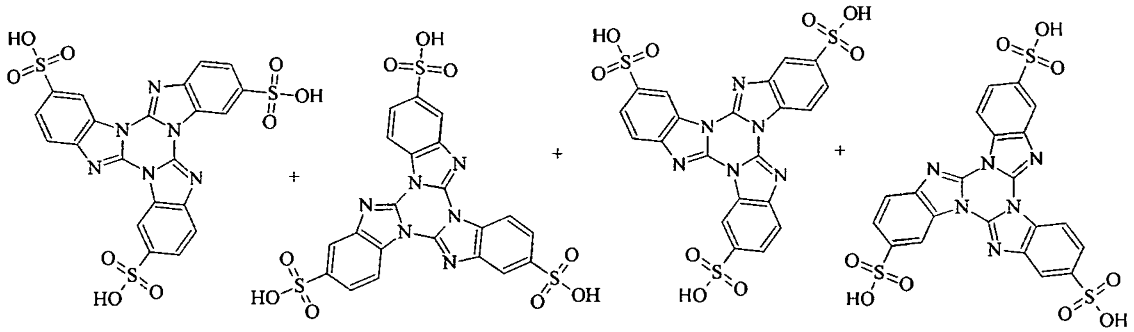
[0096] 2-Chloro-6-methyl-1H-benzimidazole (2.7 g, 16.2 mmol) was charged into round-bottom flask and heated up to 200-205 °C for about 1 hour. Reaction mixture was cooled to the room temperature. Solid material (2.2 g) was dissolved in the boiling dioxane (70 ml), resulted solution was cooled to the room temperature. Solution was filtered, filtrate was washed by dioxane (25 ml) and washing dioxane was combined with main solution. Water (40 ml) was added dropwise to obtained solution. Precipitate was filtered, washed with acetone and dried in vacuo under phosphorous oxide at about 70 °C. Yield: 1.16 g (54%).

D. Bisbenzimidazo[1',2':3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole-tricarboxylic acids

[0097] 2,8,14-Trimethyl-bisbenzimidazo[1',2':3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole(1.03 g, 2.6 mmol) was added to mixture (20 ml) of concentrated sulfuric acid and glacial acid (ratio 8:12). Then powder of chromium trioxide (3.5 g) was added slowly with cooling of reaction mixture. The mixture was stirred for 3 hours at room temperature. Water (20 ml) was added dropwise to the reaction mixture with cooling (20-40°C). Precipitate was filtered and washed with a large volume of water and diluted hydrogen chloride solution (30 ml). Then a precipitate was dried in vacuo under phosphorous oxide. Yield: 0.72 g (57.6%).

Example 3

[0098] The example describes synthesis of the mixture of bisbenzimidazo[1',2':3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole-trisulfonic acids, the heterocyclic molecular system of which is presented in Table 4, structural formula 29:



A. Synthesis of bisbenzimidazo[1',2':3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole

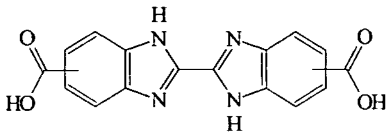
[0099] 2-Chloro-1H-Benzimidazole (4 g, 0.026 mol) was heated up to 200-220°C and agitated for half hour (until hydrogen chloride stopped to evolve). Nitrobenzene was added into reaction mass and boiled for 25 minutes with agitation. After self cooling down to ~80°C it was filtered and rinsed with acetone. Filter cake was dried at ~100°C. Yield 2.1 g (70%).

B. Synthesis of the mixture ofbisbenzimidazo[1',2':3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole-trisulfonic acids

[0100] Bisbenzimidazo[1',2':3,4;1",2":5,6][1,3,5]triazino[1,2-a]benzimidazole (2.0 g, 0.006 mol) was charged into 20% oleum (20 ml) and agitated overnight. After that the reaction mass was diluted with water (28.2 ml). Precipitate was filtered and rinsed with concentrated hydrochloric acid, 1,4-dioxane and acetone. The product was dried in a desiccator. Yield 1.32 g (40%).

Example 4

[0101] The example describes synthesis of 2,2'-bibenzheteroazole heterocyclic compounds represented by the Table 3, structural formula 8:



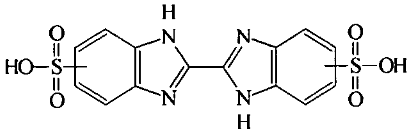
1H,1'H-2,2'-bibenzimidazole-5,5'-dicarboxylic acid

[0102] O-methyl-1,1,1-trichloroacetimidate was added (0.4 ml, 0.57 g, 3.2 mmol) to a suspension of 3,4-diaminobenzoic acid (1.0 g, 6.6 mmol) in anhydrous methanol (100 ml). The reaction mixture was stirred for 48 h at ambient conditions. Resultant yellow solid material was filtered off, dried in vacuum to a constant weight. Yield 0.43 g (41 %).

[0103] For further purification *1H,1'H-2,2'-bibenzimidazole-5,5'-dicarboxylic acid* was dissolved in dimethylsulfoxide taken in a ratio of 0.85 g/37 ml and water was added slowly (5 ml) to resultant solution. The mixture was stirred for 30 min., solid material formed was filtered off, washed with ethanol (2 x 30 ml) and dried in vacuum to a constant weight. NMR ^{1}H spectrum (Brucker Avance 600 instrument; solvent d_6-dimethyl sulfoxide; δ, ppm; J, Hz): 7.74 d.d (2H^b, $^3J_{ba}$ = 7.5), 7.93 d (2H^a, $^3J_{ab}$ = 7.5), 8.28 d (2H^x), 12.89 br.s (2NH and 2COOH), 13.94 br.s (2NH and 2COOH). Mass-spectrum (MALDI positive mode, Ultraflex TOF/TOF Bruker Daltonics instrument): 322 (100%) [M$^{+\bullet}$], 304 (45%) [M$^{+\bullet}$ - H_2O], 277 (50%) [M$^{+\bullet}$ - CO_2H].

Example 5

[0104] The example describes syntheses of 2,2'-bibenzheteroazole heterocyclic compounds shown in Table 3, structural formula 11:

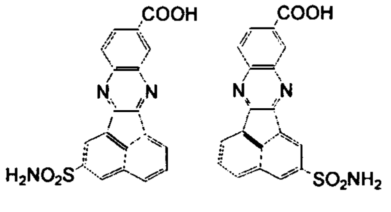


1H,1'H-2,2'-bibenzimidazole-5,5'-disulfonic acid

[0105] A round-bottom 3 neck flask was charged with 3,4-diaminobenzenesulfonic acid (8.0 g, 42.5 mmol) and anhydrous MeOH (0.85 L). O-Methyl-1,1,1-trichloroacetimidat was added (2.8 mL, 3.74 g, 21.2 mmol). The resultant suspension was stirred for 24 h at ambient conditions. Additional amount of O-methyl-1,1,1- trichloroacetimidat was added (1.4 mL, 1.87 g, 10.5 mmol) after this time, then reaction mixture was stirred for 72 h at ambient conditions, heated for 3 h at 50° C and triethylamine (14 mL, 9.4 g, 93.5 mmol) was added. Stirring was continued at this temperature for 18 hours. Then reaction mixture was cooled to 30° C, and an intensive flow of dry HCl was passed through the solution until a precipitate was formed. The suspension was filtered off at 40° C, precipitate was washed with MeOH (4x150 mL, stirring of suspension for 10-15 min each turn) and with MeOH-HCl 3.5% solution (100 mL, 1 h of stirring). Product *1H,1'H-2,2'-bibenzimidazole-5,5'-disulfonic acid* was pale yellow or colorless, weight 3.5 g, yield 42%. It may contain own hydrochloride as a salt NMR ^{1}H spectrum (Brucker Avance 300 instrument; solvent d_6-dimethyl sulfoxide; δ, ppm; J, Hz): 5.27 br.s (-SO_3H in exchange with H_2O and NH) 7.73 m (2H^a,2H^b), 8.01 br.s (2H^x). NMR ^{13}C {^{1}H} spectrum (Brucker Avance 300 instrument; solvent d_6-dimethyl sulfoxide; δ, ppm): 113.00, 115.41, 123.27, 136.44, 137.60, 142.24, 145.34.

Example 6

[0106] The example describes syntheses of a mixture of 9-carboxy-acenaphthoquinoxaline-2-sulfonamide and 9-carboxy-acenaphthoquinoxaline-5-sulfonamide shown in Table 5, structural formula 30



A. Synthesis of 9-carboxy-acenaphthoquinoxaline

[0107] A solution of 3.4-diaminobenzoic acid hydrochloride (1.88 g, 0.01 mol) in 75 ml of water was added to the suspension of acenaphthoquinone (1.82 g, 0.01 mol) in 80 ml of acetic acid. The reaction mixture was heated to 95-100°C, treated at this temperature for 15 min with stirring, and cooled. The precipitate was separated by filtration and washed with acetic acid. The final product yield was 2.6 g (87%). Mass spectrum (VISION 2000 spectrometer, negative ion reflection mode): *m/z,* 298.5; mol. wt., 298.29; electronic absorption spectrum (Ocean PC 2000 spectrometer, aqueous solution of ammonium salt): λ_{max1} = 235 nm, and λ_{max2} = 320 nm.

B. Synthesis of the mixture of 9-carboxy-acenaphthoquinoxaline-2-sulfonic acid and 9-carboxy-acenaphthoquinoxaline-5-sulfonic acid

[0108] 9-Carboxy-acenaphthoquinoxaline (2.0 g, 0.0067 mol) was added to 20 ml of 30% oleum and kept with stirring for 3.5 h at 80-90°C. Then, the reaction mixture was diluted with 36 ml of water and the precipitate was separated by filtration, reprecipitated from acetic acid (100 ml), filtered, and washed with acetone. The final product yield was 1.92 g (76%). Mass spectrum (VISION 2000 spectrometer, negative ion reflection mode): m/z, 377.1; mol. wt., 378.36; electronic absorption spectrum (Ocean PC 2000 spectrometer, aqueous solution of ammonium salt): λ_{max1} = 235 nm, and λ_{max2} = 320 nm.

C. Synthesis of the mixture of chlorides of 9-carboxy-acenaphthoquinoxaline-2-sulfonic acid and 9-carboxy-acenaphthoquinoxaline-5-sulfonic acid

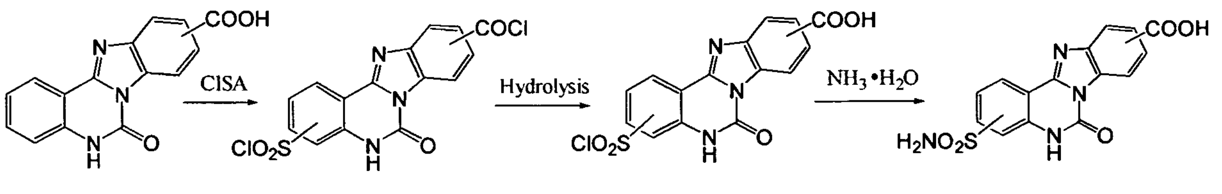
[0109] A mixture of 9-carboxy-acenaphthoquinoxaline-2-sulfonic acid and 9-carboxy-acenaphthoquinoxaline-5-sulfonic acid (1.8 g, 0.0047 mol) was added to chlorosulfonic acid (18 ml). Then, 0.3 g of NaCl was added and the reaction mixture was kept with stirring for 3 hours at 80-85°C, cooled, and poured into 350 g of ice. The precipitate was separated by filtration and washed until neutral pH with ice-cold water. The final product yield was 8-9 g of a filter-cake.

D. Synthesis of the mixture of 9-carboxy-acenaphthoquinoxaline-2-sulfonamide and 9-carboxy-acenaphthoquinoxaline-5-sulfonamide

[0110] The filter-cake of the mixture of chlorides of 9-carboxy-acenaphthoquinoxaline-2-sulfonic acid and 9-carboxy-acenaphthoquinoxaline-5-sulfonic acid (8-10 g) was added to 20 ml of ammonia and the mixture was kept at 3-5°C for 0.5 hour and then stirred under ambient conditions for 0.5 hour. The obtained ammonia solution was filtered and diluted with isopropanol (~30 ml). The precipitate was separated by filtration and washed on a filter with isopropanol. The final product yield was 1.2 g (67%). Mass spectrum (VISION 2000 spectrometer): m/z, 377.2; mol. wt., 377.37; electron absorption spectrum (Ocean PC 2000 spectrometer, aqueous solution of ammonium salt): λ_{max1} = 235 nm, and λ_{max2} = 320 nm. Elemental analysis: C, 60.22; H, 2.91; N, 11.11;; anal calcd. for $C_{18}H_{10}N_2O_3S$: C, 60.47; H, 2.94; N, 11.13; O, 16.96; S, 8.50.

Example 7

[0111] This example describes the synthesis of a mixture of sulfonamide-carboxylic acids of 6,7-dihydrobenzimidazo[1,2-c]quinazoline-6-one shown in Table 6 structural formula 50, which was performed according to the following scheme:



[0112] A mixture of 6,7-dihydrobenzimidazo[1,2-c]quinazoline-6-one-9-carboxylic acid and 6,7-dihydrobenzimidazo[1,2-c]quinazoline-6-one-10-carboxylic acid (5.0 g) was stirred with chlorosulfonic acid (50ml) at 95°C for 4 hours. Then, the reaction mass was poured into ice (150 g). The precipitate was separated by filtration and washed with ice-cold water (100 ml) until neutral reaction of the wash water. According to HPLC data, the residue on the filter contained 91.5% of the target product and 5% of a carboxysulfonic acid derivative.

[0113] This residue was introduced by small portions into aqueous ammonia solution (50 ml), and the mixture was stirred for about one hour at room temperature. Then, the ammonia solution was acidified to pH 2.5 by adding sulfuric acid. The precipitate was filtered, suspended in 3% hydrochloric acid (100 ml), and filtered again. The residue was washed with water (60 ml). This procedure yielded 3.9 g of 2(3)-sulfonamide-6,7-dihydrobenzimidazo[1,2-c]quinazoline-6-one-9-carboxylic acid and 2(3)-sulfonamide-6,7-dihydrobenzimidazo[1,2-c]quinazoline-6-one-10-carboxylic acid mixture (the product comprises 87% of the target compound and 5% of a carboxysulfonic acid derivative). The precipitate was air dried at 105 °C.

[0114] The mass spectrum of the product recorded using a Vision 2000 spectrometer was as follows: *m*/*z*, 358.6; mol. wt., 358.04. The electronic absorption spectrum of an aqueous solution of the product measured using an Ocean PC 2000 UV/VIS spectrophotometer showed the absorption maxima at λ_{max1}= 325 nm and λ_{max2} = 335-340 nm. The elemental analyses gave the following results (%): C, 50.28; H, 2.81; N, 15.64; S, 8.95 (anal. calcd. for $C_{15}H_{10}N_4O_5S$); C, 50.63; H, 2.88; N, 16.01 (found).

Example 8

[0115] This example describes the synthesis of a (4a,5a,16b,16d-tetrahydroanthra[9,1,2-*cde*]benzo[*rst*]pentaphene-5,10-dione, disilfonic acid shown in Table 7, #71.

[0116] Violanthrone was added to chlorosulfonic acid (50 ml) at ambient conditions. Then reaction mass was agitated at 85-90°C for 15 hours. After self cooling the reaction mass was added by parts to water (600 ml). Precipitate was filtered and rinsed with water until filtrate became colored. Filter cake was agitated in the boiling water for two hours. The filter cake was dissolved. The product was precipitated by addition of concentrated hydrochloric acid (600 ml). Precipitate was filtered, washed with 6 N hydrochloric acid (200 ml) and dried in oven (~100°C). Yield 11.8 g.

Example 9

[0117] This example describes the synthesis of a (bisbenzimidazo[1,2-*c*:2',1'-*i*]benzo[*lmn*]-3,8-phenanthroline-6,9-dione, disilfonic acid shown in Table 7, #74.

[0118] Cis-dibenzimidazole of 1,4,5,8- naphtalentetracarboxylic acid (10 g) was added to 20% Oleum (30 ml) at room temperature. The reaction mixture was stirred for 4 hrs at 40-45°C. Then water (60 ml) was added followed by 25% aqueous ammonia (49 ml) at <30°C and the resulting precipitated material filtered out. This acid filter cake was dissolved in water (1 liter), neutralized with ammonia to pH=5.5 and desalted with ultrafiltration. Yield 12.0 g (per dry).

Example 10

[0119] This example describes the preparation of an optically anisotropic layer from a solution comprising a binary mixture of a host compound (4,4'-(5,5-dioxidodibenzo[b,d]thiene-3,7-diyl)dibenzenesulfonic acid) denoted hereafter as H1(see Table 2, structure 1) and guest particles ((bisbenzimidazo[1,2-c:2',1'-*i*]benzo[*lmn*]-3,8-phenanthroline-6,9-dione, disilfonic acid) denoted hereafter as G1 (see Table 7, structure 74). Said mixture is capable of forming a guest-host system. The organic compound H1 is capable of forming a host matrix of the guest-host system. The stack (columns) comprised of organic compound G1 molecules serve as guest, can align together with stacks (columns) of H1 molecules. Thus, G1 as guest provides additional absorption spectrum for at least one principal direction of the anisotropic host matrix in at least one subrange.

[0120] H1/G1 = 75/25 mole % mixture was prepared as follows: 0.595g of H1 was dissolved in 100 g of de-ionized water (conductivity ~5 μSm/cm); suspension was mixed with a magnet stirrer. While stirring, 25 ml of 20% wt. KOH was gradually (during 15min) added drop-by-drop into suspension until a clear solution was formed. Separately, 0.105g of G1 was dissolved in 20 g of de-ionized water. While stirring a G1 water suspension, 5 ml of 20% wt. KOH was gradually added until a clear solution was formed. Clear solutions of H1 and G1 were mixed together to form 150.7 g of a clear solution. This mixture was concentrated on a rotary evaporator to remove an excess of water and form 10g of a binary mixture representing a Lyotropic Liquid Crystal (LLC) solution. The total concentration of mixture (H1 + G1) C_{TOT} was equal to 10%.

[0121] Fisherbrand microscope glass slides were prepared for coating by treating in a 10% NaOH solution for 30 min, rinsing with deionized water, and drying in airflow with the compressor. The obtained LLC solution was applied at a temperature of 22 °C and a relative humidity of 55% onto the glass panel surface with a Buschman® microgrooved stainless steel rod #1.5 which was moved at a linear velocity of 100 mm/s. The film was dried at the same humidity and temperature.

[0122] In order to determine the optical characteristics of the optically anisotropic layer, thickness, optical retardation and transmission spectra were measured in a wavelength range from approximately 320 to 700 nm using Dectak^{3}ST electromechanical profilometer, Axometrics Axoscan Mueller Matrix spectropolarimeter and Cary 500 Scan spectrophotometer respectively. Optical transmission of the optically anisotropic layer was measured using light beams linearly polarized parallel and perpendicular to the coating direction (T_{par} and T_{per}, respectively). The obtained data were used to calculate the refractive indices (n_x, n_y, and n_z) presented in Figure 12. Two principal directions for refractive indices n_x and n_y belong to xy-plane coinciding with a plane of the compensation panel and one principal direction for refractive index (nz) coincides with a normal line to the compensation panel. The obtained optically anisotropic layer is characterized by the thickness equal to 250 nm and two principal refractive indices (n_y and n_z) which possess anomalous spectral dispersion in a subrange approximately from 350 nm to 450 nm.

[0123] Figure 13 shows refractive indices (n_x, n_y, and n_z) of an optically anisotropic layer prepared from a solution comprising a binary mixture of the same host compound and guest particles. In this case the ratio H1/G1 was equal to 08/02 and total concentration of mixture (H1 + G1) C_{TOT} was equal to 7%. The refractive indexes n_y, and n_z possess anomalous spectral dispersion in a subrange approximately from 475 nm to 575 nm.

Example 11

[0124] This example describes preparation of an optically anisotropic layer from a solution comprising a threefold mixture of host compound (4,4’-(5,5-dioxidodibenzo[b,d]thiene-3,7-diyl)dibenzenesulfonic acid) denoted hereafter as H1(see Table 2, structure 1); first guest particles (bisbenzimidazo[1,2-*c*:2’,1’-*i*]benzo[*lmn*]-3,8-phenanthroline-6,9-dione, disilfonic acid, 22 mole%) denoted hereafter as G1 (see Table 7, structure 74), and second guest particles (4a,5a,16b,16d-tetrahydroanthra[9,1,2-*cde*]benzo[*rst*]pentaphene-5,10-dione, disilfonic acid, 8 mole %) denoted hereafter as G2 (see Table 7, structure 71, where k = 2), Said mixture is capable of forming a guest-host system. The organic compound H1 is capable of forming a host matrix of the guest-host system. The stack (columns) comprising organic compounds G1 and G2 molecules serve as a guest capable to align together with stacks (columns) of H1 molecules. Thus, G1 and G2 as a guest provide additional absorption spectrum for at least one principal direction of the anisotropic host matrix in at least one subrange.

[0125] H1/G1/G2 = 70/22/8 mole % mixture was prepared as follows: 0.523 g of H1 was dissolved in 100 g of de-ionized water (conductivity ~5μSm/cm); suspension was mixed with a magnet stirrer. While stirring, 23 ml of 20% wt. KOH was gradually (during 15 min) added drop-by-drop into suspension until a clear solution was formed. Separately, 0.96 g of G1 and 0.15 g of G2 were dissolved in 20 g of de-ionized water. While stirring a G1 and G2 combined suspension in water, 6 ml of 20% wt. KOH was gradually added until a clear solution was formed. Clear solutions of H1 and G1+G2 were mixed together to form 145 g of another clear solution. This mixture was concentrated on a rotary evaporator to remove an excess of water and form 10 g of a threefold mixture representing a Lyotropic Liquid Crystal (LLC) solution.

[0126] Fisherbrand microscope glass slides were prepared for coating by treating in a 10% NaOH solution for 30 min, rinsing with deionized water, and drying in airflow with the compressor. The obtained LLC solution was applied at a temperature of 22 °C and a relative humidity of 55% onto the glass panel surface with a Buschman® microgrooved stainless steel rod #1.5 which was moved at a linear velocity of 100 mm/s. The film was dried at the same humidity and temperature.

[0127] In order to determine the optical characteristics of the optically anisotropic layer, thickness, optical retardation and transmission spectra were measured in a wavelength range from approximately 400 to 700 nm using Dectak^{3}ST electromechanical profilometer, Axometrics Axoscan Mueller Matrix spectropolarimeter and Cary 500 Scan spectrophotometer respectively. The optical transmission of the optically anisotropic layer was measured using light beams linearly polarized parallel and perpendicular to the coating direction (T_{par} and T_{per}, respectively). The obtained data were used to calculate the refractive indices (n_x, n_y, and n_z) presented in Figure 14. Two principal directions for refractive indices n_x and n_y belong to xy-plane and one refractive index (nz) corresponds to the thickness direction. The obtained optically anisotropic layer is characterized by the thickness equal to 250 nm and two principal refractive indices (n_y and n_z) which possess anomalous spectral dispersion in a subrange approximately from 500 nm to 625 nm.

[0128] Figure 15 shows refractive indices (n_x, n_y, and n_z) of an optically anisotropic layer prepared from a solution comprising a threefold mixture of the same host compound (H1) and guest particles of two types (G1 and G2). In this case the ratio H1/G1/G2 was equal to 0.75/0.15/0.1 and total concentration of mixture (H1 + G1 +G2) C_{TOT} was equal to 8%. The refractive indexes n_y, and n_z possess anomalous spectral dispersion in a subrange approximately from 475 nm to 575 nm of the visible spectral range.

[0129] Figure 16 shows refractive indices (n_x, n_y, and n_z) of an optically anisotropic layer prepared from a solution comprising a threefold mixture of the same host compound (H1) and guest particles of two types (G1 and G2). In this case the ratio H1/G1/G2 was equal to 0.75/0.18/0.07 and total concentration of mixture (H1 + G1 +G2) C_{TOT} was equal to 12%. The refractive indexes n_y, and n_z possess anomalous spectral dispersion in a subrange approximately from 475 nm to 625 nm of the visible spectral range.

[0130] Figure 17 shows refractive indices (n_x, n_y, and n_z) of an optically anisotropic layer prepared from a solution comprising a threefold mixture of the same host compound (H1) and guest particles of two types (G1 and G2). In this case the ratio H1/G1/G2 was equal to 0.70/0.22/0.08 and total concentration of mixture (H1 + G1 +G2) C_{TOT} was equal to 12%. The refractive indexes n_y, and n_z possess anomalous spectral dispersion in a subrange approximately from 500 to 625 nm of the visible spectral range.

[0131] Figure 18 shows a comparison of refractive indices (n_x, n_y, and n_z) of two optically anisotropic layers, wherein one of the layers (the dashed line in Figure 18) was prepared from a solution comprising a binary mixture of a host compound (H1) and guest particles (G1), and another layer (the continuous line in Figure 18) was prepared from a solution comprising a threefold mixture of a host compound (H1) and guest particles of two types (G1 and G2). For the case shpwn in Figure 18 the ratio H1/G1 was equal to 0.8/0.2 and total concentration of mixture (H1 + G1) C_{TOT} was equal to 10%. The ratio H1/G1/G2 was equal to 0.75/0.15/0.1 and total concentration of mixture (H1 + G1 +G2) C_{TOT} was equal to 10%.

Example 12

[0132] The example describes the color-compensated vertically-aligned mode liquid crystal display (VA LCD) according to the present invention. Figure 19 schematically shows a light beam 10 and a color liquid crystal display according to the present invention. The liquid crystal display comprises a liquid crystal cell 1, a pair of polarizers - 72 and 80, arranged on each side of the liquid crystal cell, and two compensating panels, of which the panel 73 is disposed between the liquid crystal cell and the first polarizer 72, and the panel 77 is disposed between the liquid crystal cell and the second polarizer 80, consequently. The liquid crystal cell is schematically shown in Figure 5. The transmission axis 81 of the first polarizer is perpendicular to the transmission axis 88 of the second polarizer.

[0133] The first compensation panel 73 comprises an anisotropic layer of the first type 74 having slow 82 and fast 83 principal axes (the principal axes correspond to the principal axes of the dielectric tensor) lying substantially in the plane of said anisotropic layer 74, and an anisotropic layer of the second type 75 being a negative C-panel, for which the optical axis 84 is directed substantially perpendicularly to the plane of said anisotropic layer 75. The anisotropic layer 74 is arranged in such a way that the fast principal axis 83, corresponding to the lowest dielectric permittivity, of said anisotropic layer is perpendicular to the transmission axis 81 of the polarizer 72. The anisotropic layer 74 is a biaxial anisotropic layer of negative A_B-type and it is characterized by three principal refractive indices (n_x, n_y and n_z). The principal directions for refractive indices n_x and n_y belong to xy-plane coinciding with a plane of the compensation panel, and one principal direction for refractive index (n_z) coincides with a normal line to the compensation panel. The refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_y > n_z > n_x$. The optically anisotropic layer 75 made of triacetyl cellulose (TAC) possesses uniaxial properties of negative C-type and it is characterized by three principal refractive indices (n_x, n_y and n_z).

[0134] The second compensation panel 77 comprises an anisotropic layer of the first type 79 having slow 87 and fast 86 principal axes lying substantially in the plane of said anisotropic layer 79, and an anisotropic layer of the second type 78 made of triacetyl cellulose (TAC) as a negative C-panel, for which the optical axis 85 is directed substantially perpendicularly to the plane of said anisotropic layer 78. The retardation layer of the first type 79 is arranged in such a way that the fast principal axis 86 of said anisotropic layer is perpendicular to the transmission axis 88 of the polarizer 80. The anisotropic layer 79 is of negative A_B-type and it is characterized by three principal refractive indices (n_x, n_y and n_z). Two principal directions for refractive indices n_x and n_y belong to xy-plane coinciding with a plane of the compensation panel, and one principal direction for refractive index (n_z) coincides with a normal line to the compensation panel. The refractive indices n_x, n_y, and n_z obey the following condition in the visible spectral range: $n_y > n_z > n_x$.

[0135] Figure 20 shows a change of the color state versus time during field-driven switching from Black to White states at a viewing angle of $(\varphi, \theta) = (-45°, 60°)$ when thickness of each layer 74 and 79 is equal to 350 nm, and retardation of each of TAC-layers (layers 75 and 78) is equal to 50 nm. This design provides rather high photopic CR~40 at large viewing angles ~60°. The refractive indices n_x, n_y, and n_z are shown in Figure 21; they have normal spectral dispersion. In case of normal spectral dispersion the principal refractive indices increase with a decreasing of the wavelength. Also the in-plane difference of refractive indices $\Delta_{in}(\lambda) = |n_y(\lambda) - n_x(\lambda)|$ typically shows similar behavior. Back light source is presented by three equal spectral components at 450, 550 and 650 nm. Figure 20 shows that the switching from Black to White states is accompanied by a significant change of the color state.

[0136] In order to solve the color state problem the spectral dispersion of the principal refractive indices must be corrected. It is known that the refraction is a consequence of absorption. Every absorption band makes a contribution to a value of refraction coefficient. In a spectral band of the absorption one can get an anomalous dispersion in case when the refraction coefficient increases with increasing the wavelength as shown in Figure 22. The spectral dispersion is controlled by choosing the optimal spectral dependence of absorption. In this example the optically anisotropic layers are formed from a solution comprising a binary mixture of "1,1':4',1":4",1'''-quaterphenyl, disulfonic acid (the first organic compound) and (bisbenzimidazo[1,2-*c*:2',1'-*i*]benzo[*lmn*]-3,8-phenanthroline-6,9-dione, disilfonic acid (the second organic compound). Said mixture is capable to form a guest-host system as shown in Figure 23. The first organic compound is capable to form a host matrix 90 of the guest-host system. The stacks comprised of the molecules of the second organic compound 91 serve as a guest, capable to align together with stacks of host-molecules of the host matrix. Thus, the second compound as a guest provides an additional absorption spectrum for at least one principal direction of the anisotropic host matrix in at least one subrange. Figure 24 shows the principal refractive index n_y possessing an anomalous spectral dispersion ($\partial n_y(\lambda)/\partial\lambda \geq 0$) in the subrange from 450 nm to 575 nm. The continuous curve shown in Figure 24 is the refractive index calculated from an experimental absorption spectrum ky using Kramers-Kronig (K-K) relation. Deviation from the experimental measurements of the refractive indices can be explained with the fact that for the calculations the experimental data for absorption below 200 nm cannot be measured. Correction of a refractive index spectral dispersion allows significant suppressing variations of the color state during LC switching as shown in Figure 25.

Example 13

[0137] The example describes the color-compensated in-plane switching liquid crystal display (IPS LCD) according to the present invention. The display has the following design - P_{45} LC_{-45} A_{B-45} P_{-45}, wherein P_{45} is a polarizer with the transmission axis at 45°; LC_{-45} is a planar LC layer aligned with the director at -45°; $A_B\text{-}_{45}$ is a negative biaxial A_B-panel with the fast axis at -45°; P $_{-45}$ is a polarizer with the transmission axis at -45°. The performance of this optimized IPS LCD design without dispersion compensation is illustrated in Figures 26 (a) - (c). Figures show computer simulated dependencies for three wavelength: λ=450nm (a), λ=550nm (b), λ=630nm (c).

[0138] Figure 27 shows a change of the color state versus time during field-driven switching from Black to White states in this case. The refractive indices n_x, n_y, and n_z are shown in Figure 21 and have normal spectral dispersion. Figure 27 illustrates that luminance ratio at 60 deg viewing angle may be good (approximately equal to 325), however at low levels of output intensities the change in color is significant: Du'v'=0.29. In order to modify the spectral dispersion it is necessary to make the AB- panel with partial absorption along the y-direction. Figure 28(a) shows the spectral absorption, and Figure 28(b) shows the spectral refractive indices of a modified As-panel.

[0139] Figures 29(a) - (c) show that dispersion is significantly compensated. Figure 29 shows computer simulated dependencies of color-compensated IPS LCD design for three wavelengths: λ=450nm (a), λ=550nm (b), λ=630nm (c).

[0140] Correction of a refractive index spectral dispersion allows significant suppressing variations of the color state during LC switching as shown in Figure 30. Luminance ratio at 60 deg viewing angle may be good (approximately equal to 420), and even at low levels of output intensities the variation in color is small: Du'v'=0.06. For this embodiment of the liquid crystal design the thickness of the experimental A_B-panel was 0.7 microns and the absorption coefficient k_y ~ 2 mm^{-1} results in significant absorption (T~15%) along the y-axis at normal incidence. However, in this design this absorption axis coincides with the absorption axis of the output polarizer. Thus the resultant absorption was basically defined by k_x, which is small and provides transmission of approximately 90%. Even at large incidence angles ~60° the transmission remains at level higher than 70%.

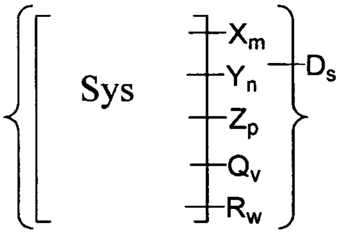
Claims

1. An optically anisotropic compensation panel (13, 17, 30, 64, 73, 77) comprising at least one optically anisotropic layer (14, 15, 18, 19, 35, 74, 75, 78, 79) on a substrate, the compensation panel possessing a spectrally controlled dispersion of refractive indices,
   wherein the layer is based on an ordered guest-host system comprising:

   an ordered anisotropic host matrix (90) comprising an organic compound transparent to electromagnetic radiation in the visible spectral range, and having three principal refractive indices ($n_{x,h}$, $n_{y,h}$ and $n_{z,h}$) possessing a normal spectral dispersion $\partial n_u(\lambda)/\partial\lambda < 0$ in the visible spectral range, wherein the subscript u is selected from the list comprising x, y and z; and

   an ordered guest component (91) comprising guest particles, the guest particles being optically anisotropic dye molecules that provide an absorption additional to an absorption of the anisotropic host matrix, realized in at least one principal direction of the anisotropic host matrix in at least one subrange of the visible spectral range, such that the optically anisotropic layer has three principal refractive indices (n_x, n_y and n_z), at least one of which satisfies the following condition where $\partial n_u(\lambda)/\partial\lambda \geq 0$ in at least one subrange of the visible spectral range, and wherein the subscript u is selected from the list comprising x, y and z.

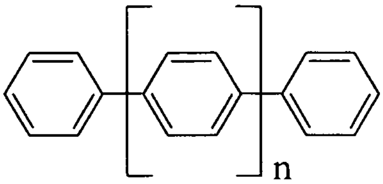
2. An optically anisotropic compensation panel according to Claim 1, wherein the organic compound for the host matrix has a general structural formula I



$$\left\{\left[\mathrm{Sys}\begin{array}{l}-X_m\\-Y_n\\-Z_p\\-Q_v\\-R_w\end{array}\right]-D_s\right\}$$

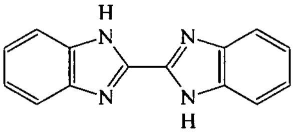
, (I)

where Sys is an at least partially conjugated polycyclic molecular system having a general structural formula from the list comprising structures II to XLVI:

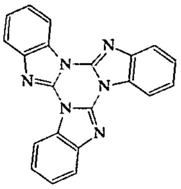


(II)

where n is a number in the range from 1 to 8



(III)



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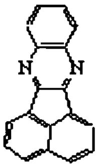
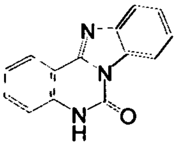


(V)



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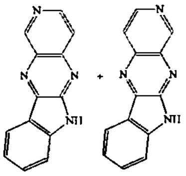

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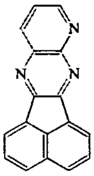

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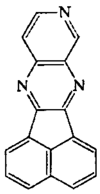
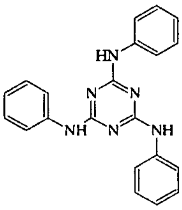
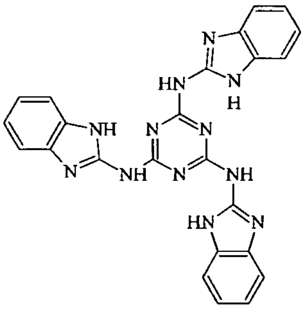


(IX)



(X)



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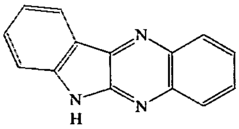

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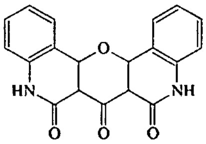

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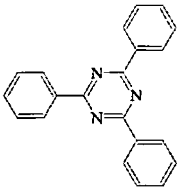

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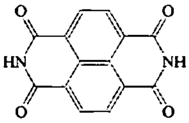

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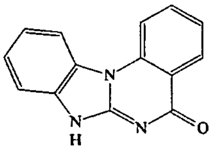

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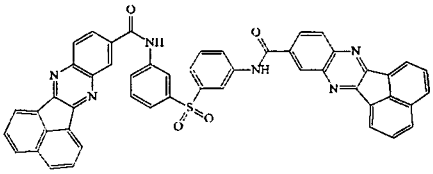

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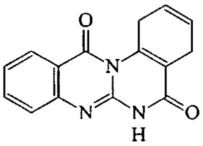

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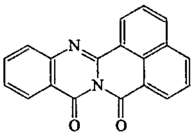

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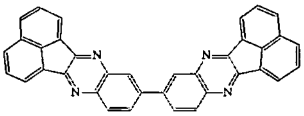

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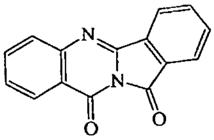

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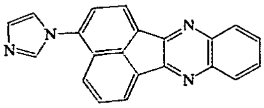

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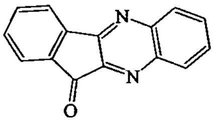

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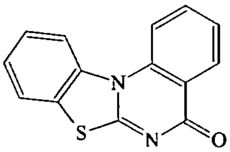

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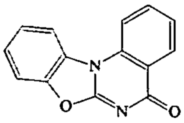

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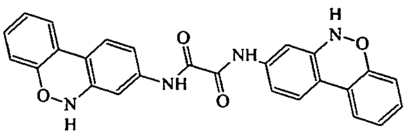

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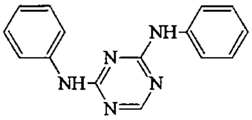

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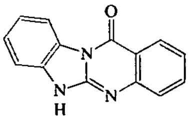

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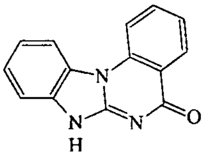

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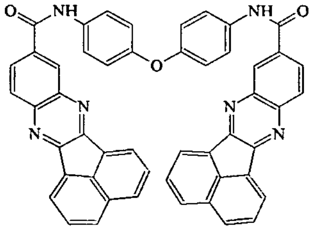

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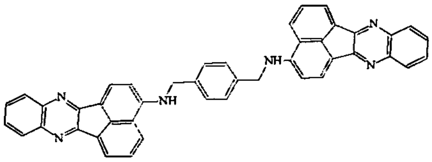

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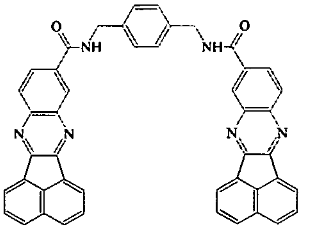

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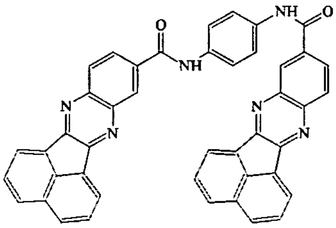

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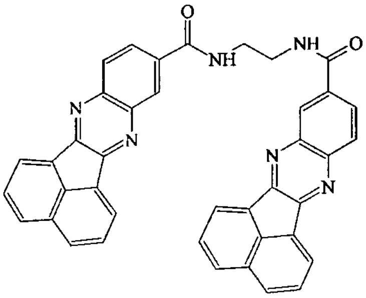

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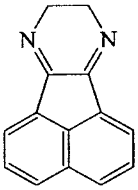

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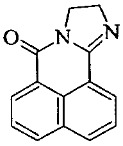

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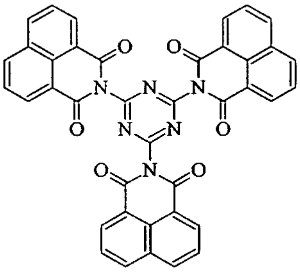

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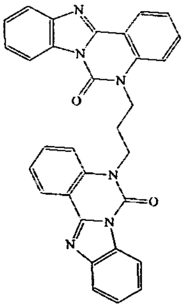

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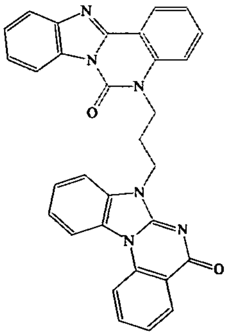

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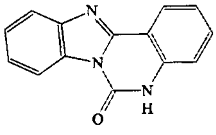
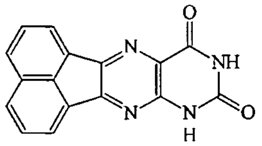


(XL)



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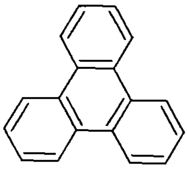

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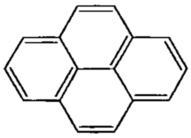

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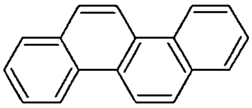

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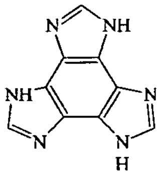

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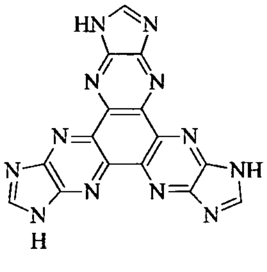


(XLVI)

and

X is a carboxylic group -COOH, *m* is 0, 1, 2, 3 or 4; Y is a sulfonic group $-SO_3H$, *n* is 0, 1, 2, 3 or 4; Z is a carboxamide, *p* is 0, 1, 2, 3 or 4; Q is a sulfonamide, v is 0, 1, 2, 3 or 4; D is a counterion; *s* is the number of counterions providing electrically neutral state of the molecule; R is a substituent selected from the list comprising CH_3, C_2H_5, Cl, Br, NO_2 F, CF_3, CN, OH, CH_3, OC_2H_5, $OCOCH_3$, OCN, SCN, NH_2, and $NHCOCH_3$, and w is 0, 1, 2, 3 or 4.

3. An optically anisotropic compensation panel according to any of Claims 1 or 2, wherein the optically anisotropic layer possesses optical properties selected from:

(a) biaxial properties of B_A-type ($n_y > n_z > n_x$ or $n_x > n_z > n_y$ in the visible spectral range), uniaxial properties of negative A-type, uniaxial properties of positive A-type, or biaxial properties of A_C-type ($n_y > n_x > n_z$ or $n_x > n_y$

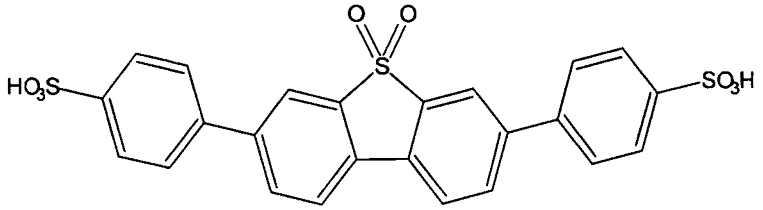
$> n_z$ (positive A_C-type) or $n_y < n_x < n_z$ or $n_x < n_y < n_z$ (negative A_C-type)), wherein each of B_A-type, negative A-type, positive A-type, and A_C-type is **characterized by** an in-plane difference of refractive indices $\Delta_{in}(\lambda)=|n_y(\lambda)-n_x(\lambda)|$, which satisfies the condition $\partial\Delta_{in}(\lambda)/\partial\lambda\geq 0$ in at least one subrange of the visible spectral range; and

(b) biaxial properties of B_A-type, biaxial properties of A_C-type, uniaxial properties of negative C-type, or uniaxial properties of positive C-type, wherein each of B_A-type, A_C-type, negative C-type, and positive C-type are **characterized by** an out-of-plane difference of refractive indices $\Delta_{out}(\lambda)=|n_z(\lambda) - n_x(\lambda)|$, and each of B_A-type and A_C-type are also **characterized by** an in-plane difference of refractive indices $\Delta_{in}(\lambda)=|n_y(\lambda) - n_x(\lambda)|$, wherein condition $\partial\Delta_{out}(\lambda)/\partial\lambda\geq 0$ or condition $\partial\Delta_{out}(\lambda)/\partial\lambda\geq 0$ and $\partial\Delta_{in}(\lambda)/\partial\lambda\geq 0$ is satisfied in at least one wavelength subrange of the visible spectral range.

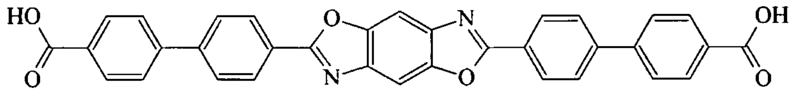
4. An optically anisotropic compensation panel according to Claim 3, wherein the in-plane difference of refractive indices $\Delta_{in}(\lambda)$ obeys the following condition: spectral dispersion factors $(\Delta_{in,450}/\Delta_{in,550})$ and $(\Delta_{in,550}/\Delta_{in,650})$ are in a range of 0.4 - 1.0, and wherein the out-of-plane difference of refractive indices $\Delta_{out}(\lambda)$ obeys the following condition: spectral dispersion factors $(\Delta_{out,450}/\Delta_{out,550})$ and $(\Delta_{out,550}/\Delta_{out,650})$ are in a range of 0.4 - 1.0, wherein $\Delta_{in,450}$, $\Delta_{in,550}$ and $\Delta_{in,650}$ are values of the in-plain differences of refractive indices and $\Delta_{out,450}$, $\Delta_{out,550}$ and $\Delta_{out,650}$ are values of the out-of-plane differences of refractive indices $\Delta_{out}(\lambda)$ at wavelengths of 450 nm, 550 nm and 650 nm respectively.

5. An optically anisotropic compensation panel according to any of Claims 2 to 4, wherein the counterion is selected from the list comprising H^+, NH_4^+, Na^+, K^+, Li^+, Ba^{++}, Ca^{++}, Mg^{++}, Sr^{++}, Cs^+, Pb^{++}, and Zn^{++}.

6. An optically anisotropic compensation panel according to any of Claims 1 to 5, wherein the organic compound has a general structural formula corresponding to one of structures 1 to 70:



(1)



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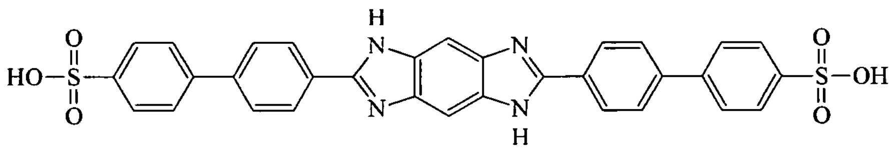

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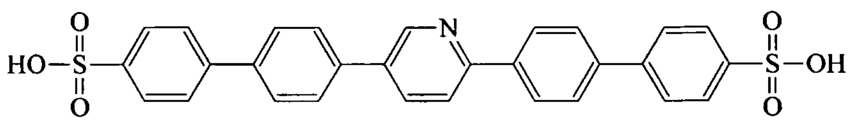

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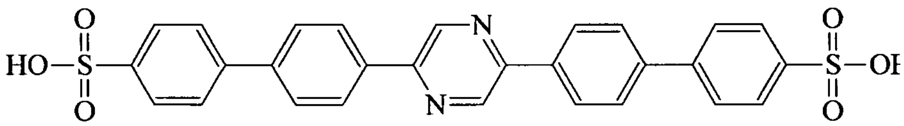

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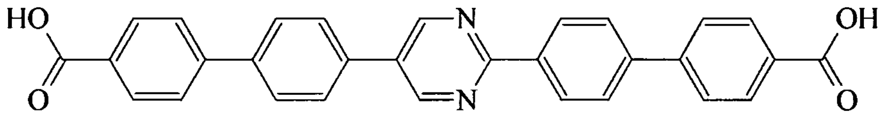

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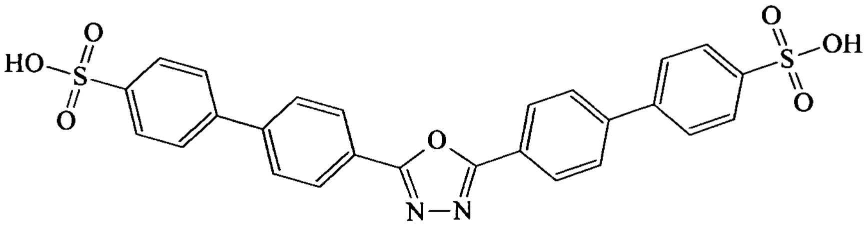

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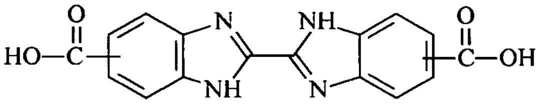

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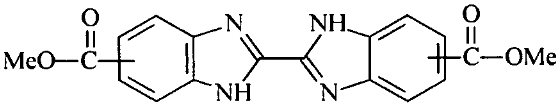

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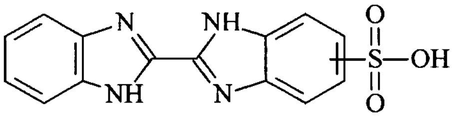

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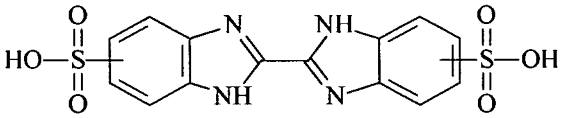

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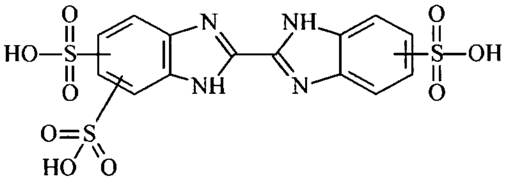

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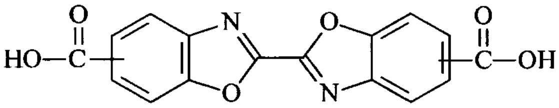

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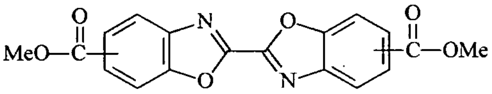

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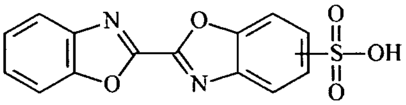

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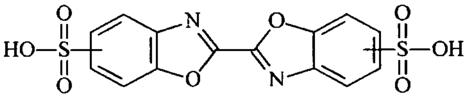

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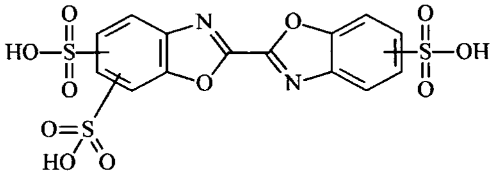

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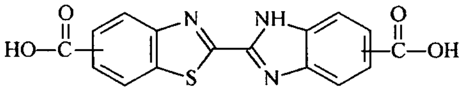

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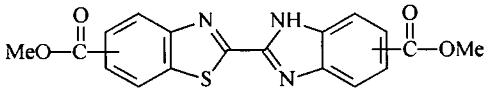

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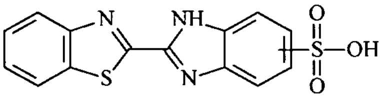

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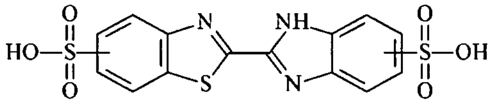

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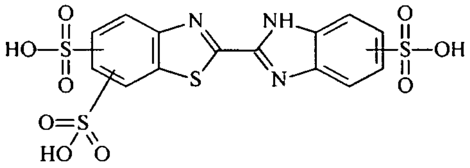

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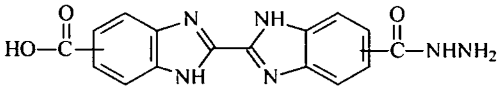

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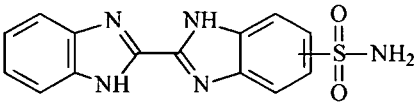

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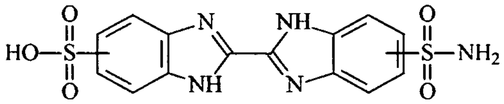

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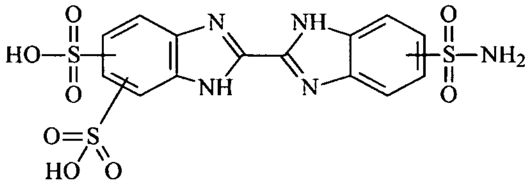

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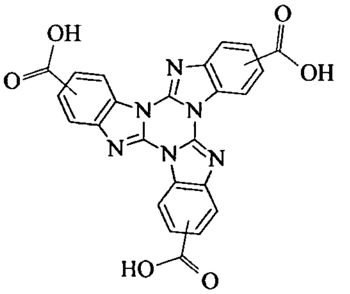

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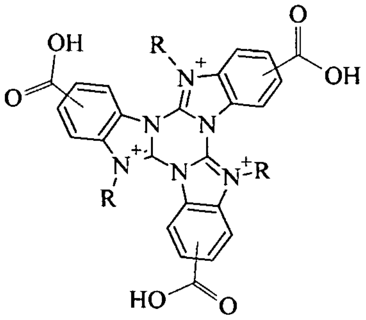
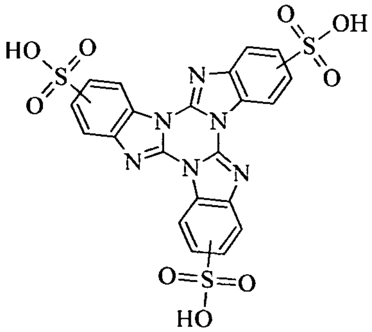


$R= CH_3, C_2H_5, C_3H_7, C_4H_9$

(28)



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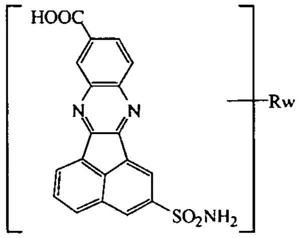

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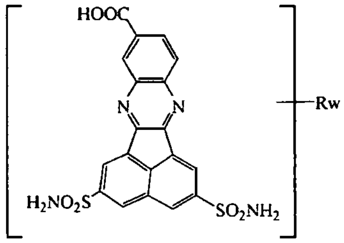

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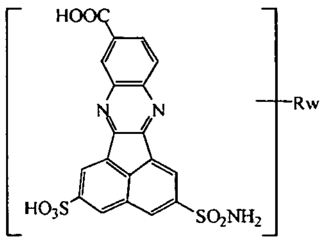

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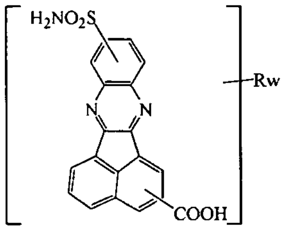

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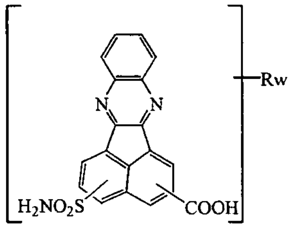

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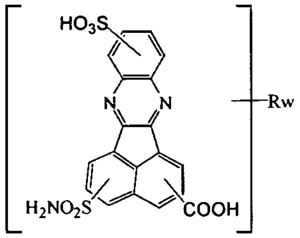

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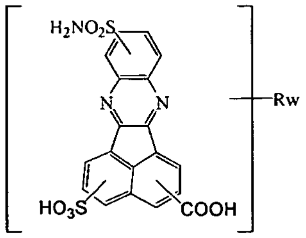

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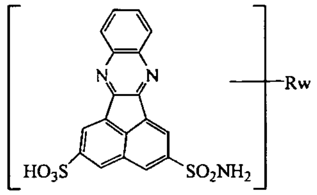

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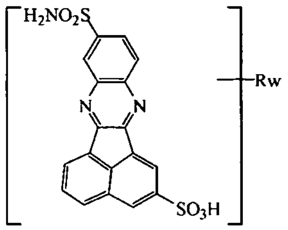

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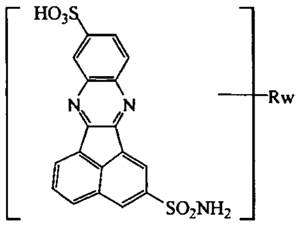

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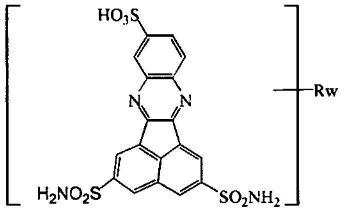

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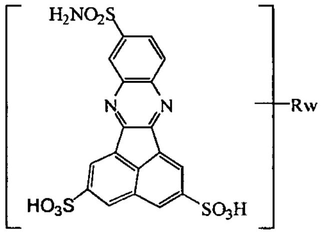

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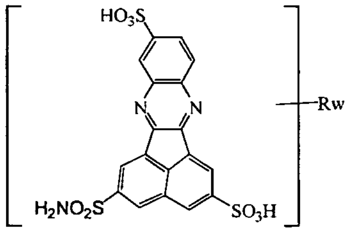

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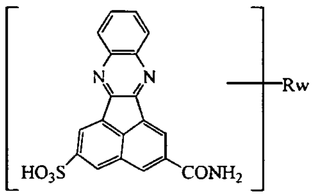

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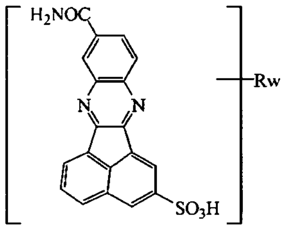

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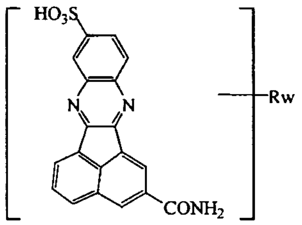

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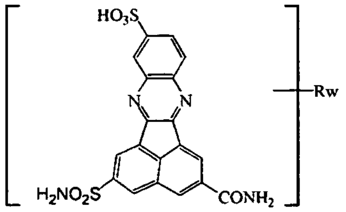

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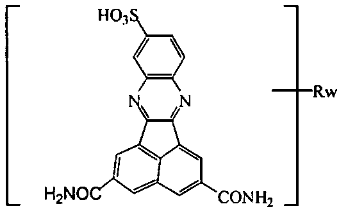

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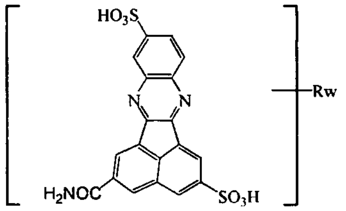

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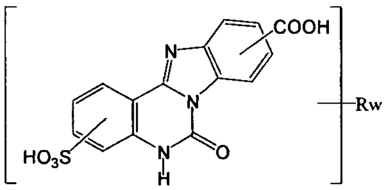

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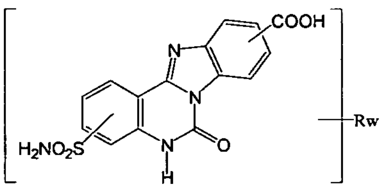

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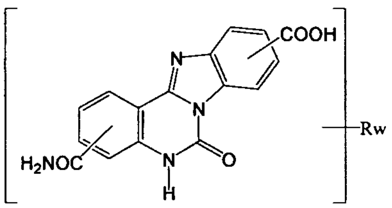

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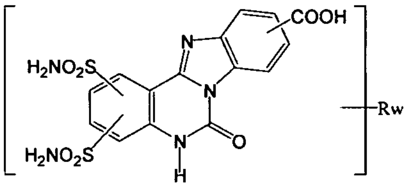

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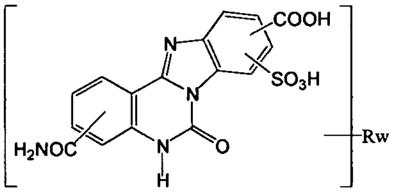

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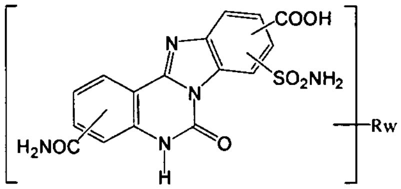

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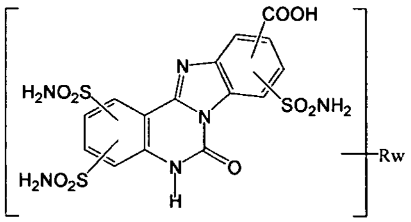

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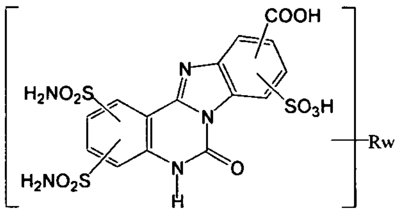

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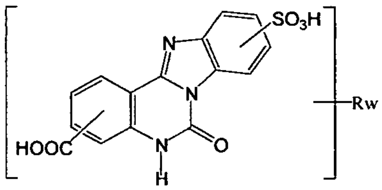

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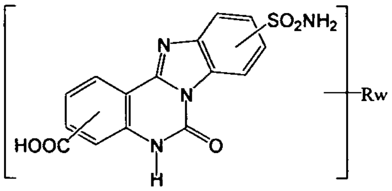

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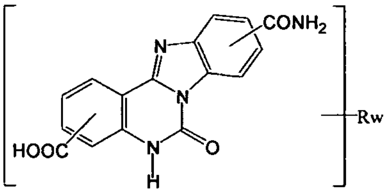

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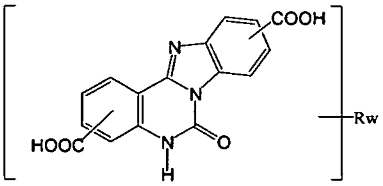

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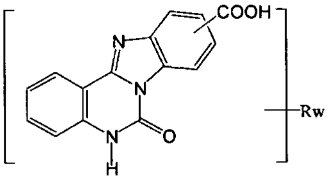

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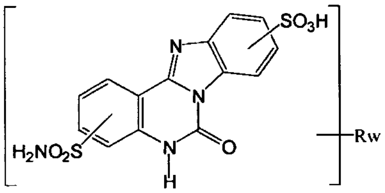

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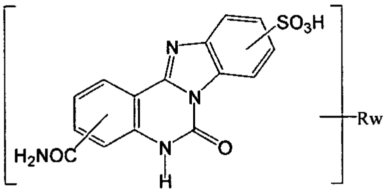

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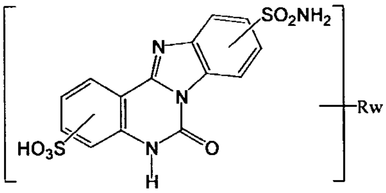

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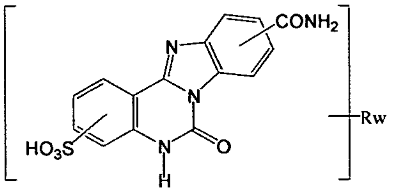

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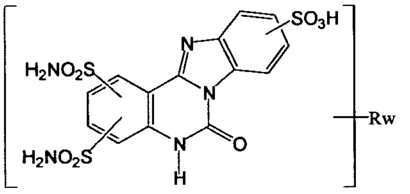

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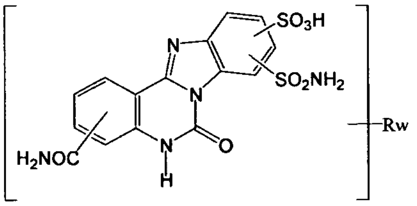

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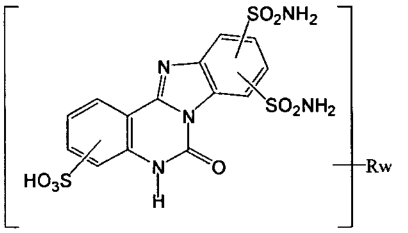

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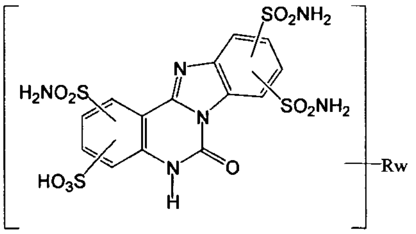

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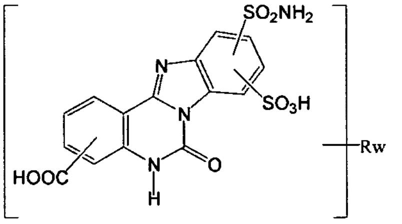


(70)

wherein, R is a substituent selected from the list comprising CH_3, C_2H_5, Cl, Br, NO_2, F, CF_3, CN, OH, CH_3, OC_2H_s, $OCOCH_3$, OCN, SCN, NH_2, and $NHCOCH_3$, and w is 0, 1, 2, 3 or 4,
wherein, Me is a methyl group.

7. An optically anisotropic compensation panel according to any of Claims 1 to 6, wherein the anisotropic host matrix possesses optical properties selected from the list comprising

a) biaxial properties of B_A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)=|\, n_{y,h}(\lambda)-n_{x,n}(\lambda)|$and/or out-of-plane difference of refractive indices $\Delta_{out,h}(\lambda)=|n_{x,h}(\lambda)-n_{z,h}(\lambda)|$;

b) uniaxial properties of positive A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)=|n_{y,h}(\lambda)-n_{x,h}(\lambda)|$;

c) uniaxial properties of negative A-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)=|n_{y,h}(\lambda)-n_{x,h}(\lambda)|$;

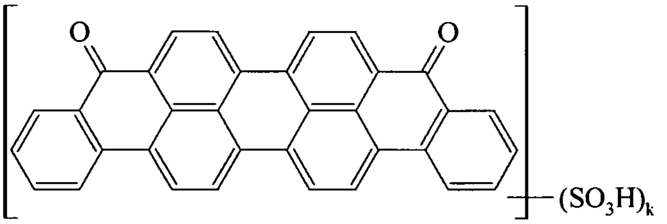
d) biaxial properties of A_C-type having an in-plane difference of refractive indices $\Delta_{in,h}(\lambda)=|\, n_{y,h}(\lambda)-n_{x,n}(\lambda)|$ and/or out-of-plane difference of refractive indices $\Delta_{out,h}(\lambda)=|n_{x,h}(\lambda)-n_{z,h}(\lambda)|$;

e) uniaxial properties of positive C-type having an out-of-plane difference of refractive indices $\Delta_{out,h}(\lambda)=|n_{x,n}(\lambda)-n_{z,h}(\lambda)|$; and

f) uniaxial properties of negative C-type having an out-of-plane difference of refractive indices $\Delta_{out,h}(\lambda)=|n_{x,h}(\lambda)-n_{z,h}(\lambda)|$;

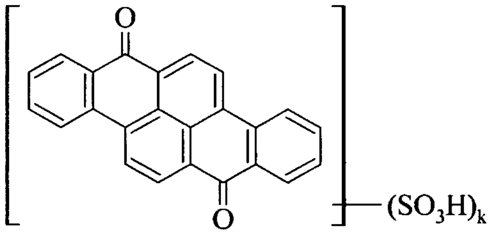
wherein for each of a) to f) condition $\partial\Delta_{out,h}\,(\lambda)/\partial\lambda<0$ and/or condition $(\partial\Delta_{in,h}(\lambda)/\partial\Delta<0$ are satisfied in the visible spectral range.

8. An optically anisotropic compensation panel according to any of Claims 1 to 7, wherein the guest particles have a general structural formula corresponding to structures 71 to 79:



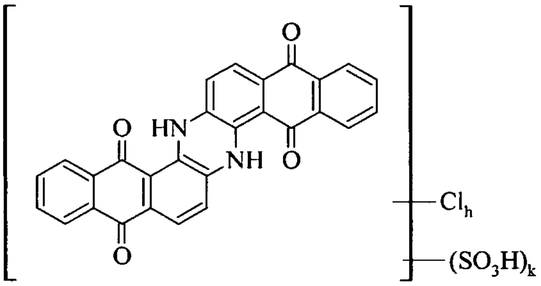
(71)

k=1,2,3,4



(72)

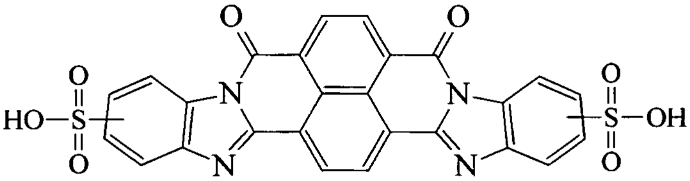
k=1,2,3,4



(73)

h=0,1

k=1,2,3,4



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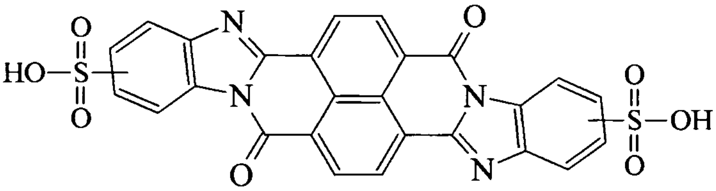

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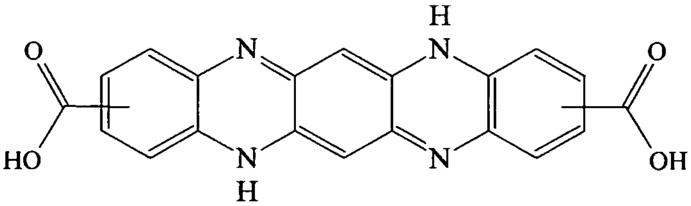

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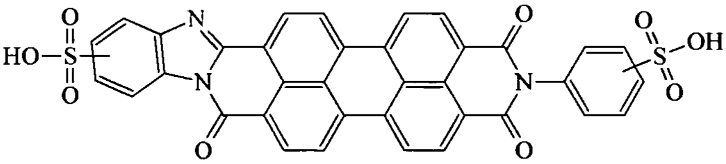

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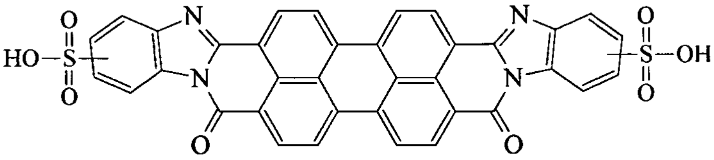
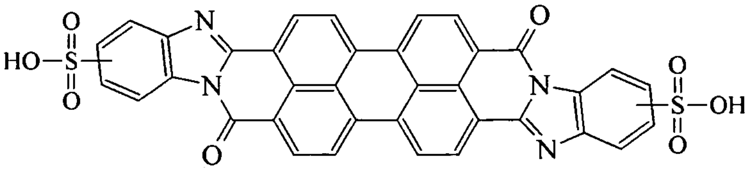


(78)



(79)

9. An optically anisotropic compensation panel according to Claim 1 to 8, wherein the substrate is made of one or several materials of the group comprising diamond, quartz, plastics, glasses, ceramics, and comprises at least one element of the group comprising color filter substrate, circuit features, multilevel interconnects, and TFT-array substrate.

10. A color liquid crystal display comprising
a liquid crystal cell (1, 57),
first and second polarizers (12, 20, 55, 56, 72, 80) arranged on each side of the liquid crystal cell, and
at least one compensation panel according to any of claims 1 to 9, located between said polarizers.

11. A liquid crystal display according to Claim 10, wherein the liquid crystal cell is an in-plane switching mode or a vertically-aligned mode cell.

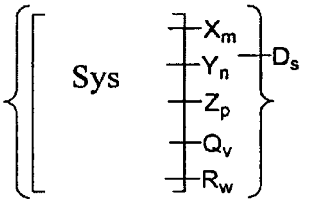
12. A liquid crystal display according to Claim 10 or 11, wherein the compensation panel is located inside the liquid crystal cell.

Patentansprüche

1. Eine optisch anisotrope Ausgleichsplatte (13,17, 30, 64, 73, 77), die mindestens eine optisch anisotrope Schicht (14, 15, 18, 19, 35, 74, 75, 78, 79) auf einem Substrat aufweist, wobei die Ausgleichsplatte über eine spektral gesteuerte Dispersion der Brechungskoeffizienten verfügt,
und wobei die Schicht auf einem geordneten Gast-Host-System basiert, das Folgendes aufweist:

    eine geordnete anisotrope Wirts-Matrix (90), die eine organische Verbindung aufweist, die durchlässig für elektromagnetische Strahlung im sichtbaren Spektralbereich ist, und drei Haupt-Brechungskoeffizienten ($n_{x,h}$, $n_{y,h}$ und $n_{z,h}$) mit einer normalen spektralen Dispersion $\partial n_u(\lambda)/\partial \Delta < 0$ im sichtbaren Spektralbereich hat, wobei der tiefgestellte Index u ausgewählt ist aus der Liste, die x, y und z aufweist; und
    eine geordnete Gast-Komponente (91), die Gast-Partikel aufweist, die Gast-Partikel sind dabei optisch anisotrope Farbstoffmoleküle, die eine Absorption zusätzlich zur Absorption der anisotropen Wirts-Matrix bieten, die in mindestens eine Hauptrichtung der anisotropen Wirts-Matrix in mindestens einem Unterbereich des sichtbaren Spektralbereichs ausgeführt wird, so dass die optisch anisotrope Schicht drei Haupt-Brechungskoeffizienten (n_x, n_y und n_z) hat, von denen mindestens eine die folgenden Bedingungen erfüllt, bei denen $\partial n_u(\lambda)/\partial \lambda \geq 0$ in mindestens einem Unterbereich des sichtbaren Spektralbereichs ist, und wobei der tiefgestellte Index u ausgewählt ist aus der Liste, die x, y und z aufweist.

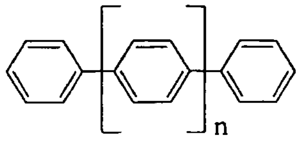
2. Eine optisch anisotrope Ausgleichsplatte gemäß Anspruch 1, wobei die organische Verbindung für die Wirts-Matrix eine generelle Strukturformel I hat,



$$\left\{ \left[\mathrm{Sys} \begin{array}{l} -X_m \\ -Y_n \\ -Z_p \\ -Q_v \\ -R_w \end{array} \right] - D_s \right\}$$

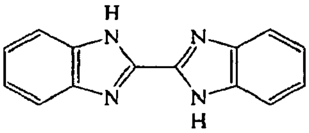
, (I)

in der Sys ein zumindest teilweise konjugiertes polyzyklisches Molekularsystem mit einer generellen Strukturformel aus der Liste ist, die die Strukturen II bis XLVI aufweist:



(II)

wobei n eine Zahl im Bereich von 1 bis 8 ist



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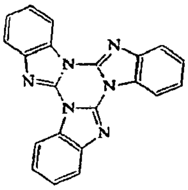

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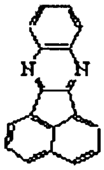

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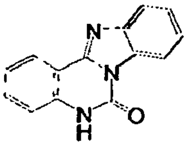

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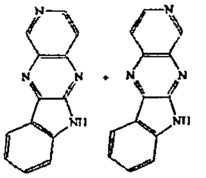

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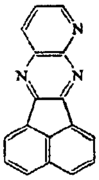

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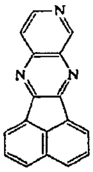

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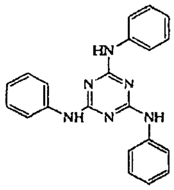

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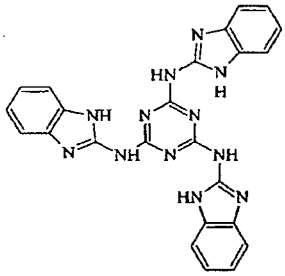

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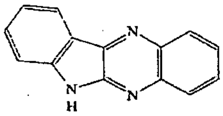

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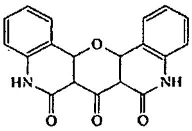

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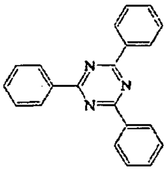

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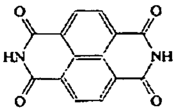

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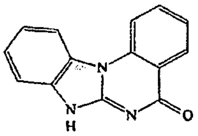

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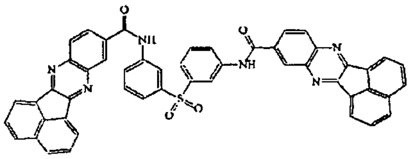

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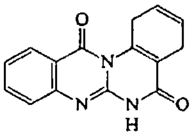
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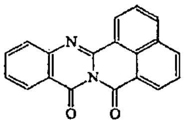
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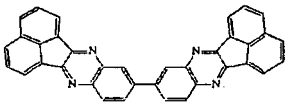
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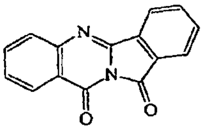
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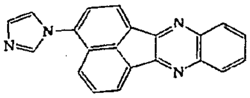
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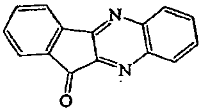
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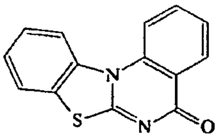
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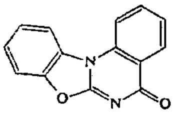
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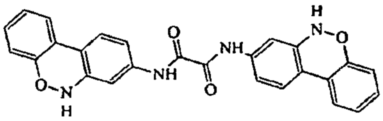
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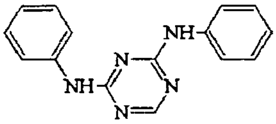
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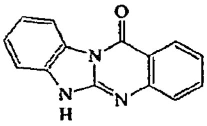

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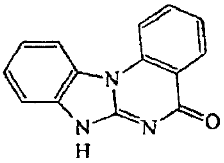

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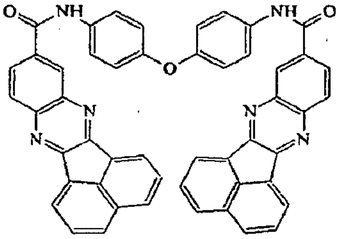

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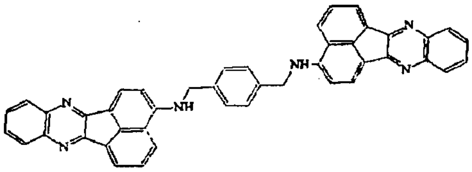

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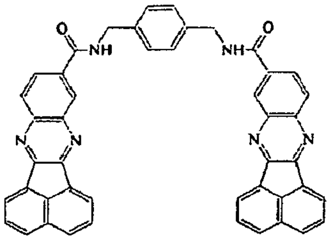

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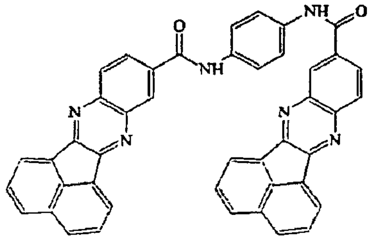

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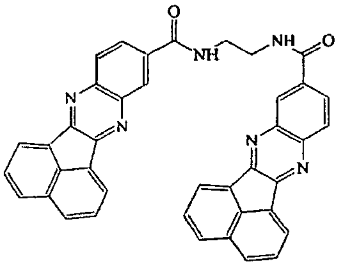

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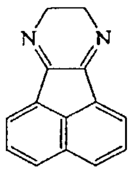

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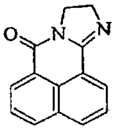

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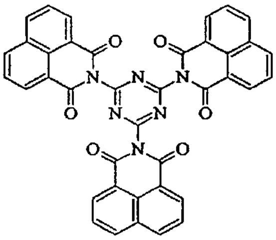

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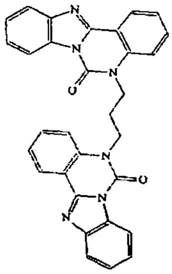

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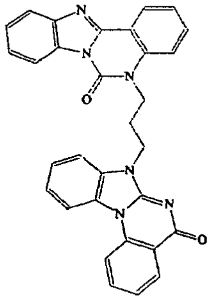

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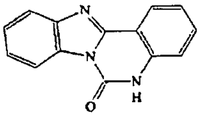

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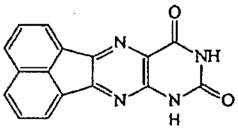

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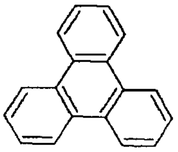

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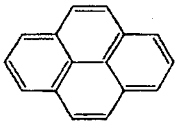

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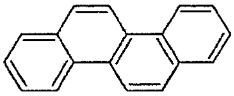

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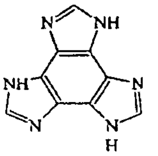

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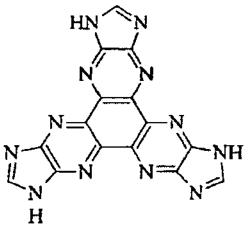


(XLVI)

und
X eine Carboxygruppe -COOH ist, *m* 0, 1,2,3 oder 4 ist; Y eine Sulfongruppe -SO_3H ist, *n* 0, 1, 2, 3 oder 4 ist; Z ein Carboxamid ist, *p* 0, 1, 2, 3 oder 4 ist; Q ein Sulfonamid ist, v 0, 1, 2, 3 oder 4 ist; D ein Gegenion ist; *s* die Anzahl der Gegenionen ist, die elektrisch neutrale Zustände des Moleküls liefern; R ein Substituent ist, ausgewählt aus der Liste, die CH_3, C_2H_5, Cl, Br, NO_2 F, CF_3, CN, OH, CH_3, OC_2Hs, $OCOCH_3$, OCN, SCN, NH_2 und $NHCOCH_3$, aufweist, und w 0, 1,2, 3 oder 4 ist.

3. Eine optisch anisotrope Ausgleichsplatte gemäß Anspruch 1 oder 2, wobei die optisch anisotrope Schicht optische Eigenschaften besitzt, die aus Folgendem ausgewählt sind:

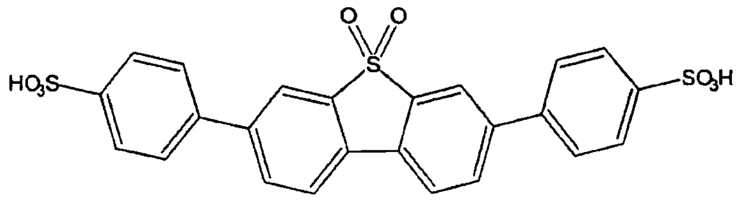
(a) biaxiale Eigenschaften des B_A-Typs ($n_y > n_z > n_x$ oder $n_x > n_z > n_y$ im sichtbaren Spektralbereich), einaxiale Eigenschaften des negativen A-Typs, einaxiale Eigenschaften des positiven A-Typs oder biaxiale Eigenschaften des Ac-Typs ($n_y > n_x > n_z$ oder $n_x > n_y > n_z$ (positiver Ac -Typ) oder $n_y < n_x < n_z$ oder $n_x < n_y < n_z$ (negativer Ac -Typ)), wobei jeder B_A-Typ, negative A-Typ, positive A-Typ und A_C-Typ **gekennzeichnet ist durch** eine Differenz in der Bezugsebene der Brechungskoeffizienten $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$, die die Bedingung $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in mindestens einem Unterbereich des sichtbaren Spektralbereichs erfüllt; und

(b) biaxiale Eigenschaften des B_A-Typs, biaxiale Eigenschaften des Ac-Typs, einaxiale Eigenschaften des negativen C-Typs oder einaxiale Eigenschaften des positiven C-Typs, wobei jeder B_A-Typ, A_C-Typ, negative C-Typ und positive C-Typ **gekennzeichnet ist durch** eine Differenz außerhalb der Bezugsebene der Brechungskoeffizienten $\Delta_{ou}t(\lambda)=|n_z(\lambda) - n_x(\lambda)|$, und jeder B_A-Typ und A_C-Typ darüberhinaus **gekennzeichnet ist durch** eine Differenz in der Bezugsebene der Brechungskoeffizienten $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$, wobei die Bedingung $\partial\Delta_{out}(\lambda)/\partial\Delta \geq 0$ oder die Bedingung $\partial\Delta_{out}(\lambda)/\partial\lambda \geq 0$ und $\partial\Delta_{in}(\lambda)/\partial\lambda \geq 0$ in mindestens einem Wellenlängen-Unterbereich des sichtbaren Spektralbereichs erfüllt ist.

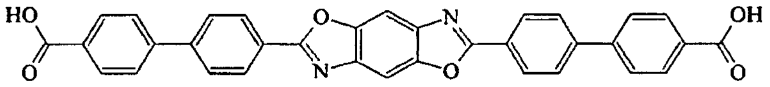
4. Eine optisch anisotrope Ausgleichsplatte gemäß Anspruch 3, wobei die Differenz in der Bezugsebene der Brechungskoeffizienten $\Delta_{in}(\lambda)$ der folgenden Bedingung unterliegt: spektrale Dispersionsfaktoren $(\Delta_{in,450}/\Delta_{in,550})$ und $(\Delta_{in,550}/\Delta_{in,650})$ liegen in einem Bereich von 0,4 -1,0, und wobei die Differenz außerhalb der Bezugsebene der Brechungskoeffizienten $\Delta_{out}(\lambda)$ der folgenden Bedingung unterliegt: spektrale Dispersionsfaktoren $(\Delta_{out,450}/\Delta_{out,550})$ und $(\Delta_{out,550}/\Delta_{out,650})$ liegen in einem Bereich von 0,4 - 1,0, wobei $\Delta_{in,450}$, $\Delta_{in,550}$ und $\Delta_{in,650}$ Werte der Differenzen in der Bezugsebene der Brechungskoeffizienten sind und $\Delta_{out,450}$, $\Delta_{out,550}$ und $\Delta_{out,650}$ Werte der Differenzen außerhalb der Bezugsebene der Brechungskoeffizienten $\Delta_{out}(\lambda)$ bei Wellenlängen von 450 nm, 550 nm bzw. 650 nm sind.

5. Eine optisch anisotrope Ausgleichsplatte gemäß eines der Ansprüche 2 bis 4, wobei das Gegenion ausgewählt ist aus der Liste, die H^+, NH_4^+, Na^+, K^+, Li^+, Ba^{++}, Ca^{++}, Mg^{++}, Sr^{++}, Cs^+, Pb^{++} und Zn^{++} aufweist.

6. Eine optisch anisotrope Ausgleichsplatte gemäß eines der Ansprüche 1 bis 5, wobei die organische Verbindung eine generelle Strukturformel hat, die einer der Strukturen 1 bis 70 entspricht:



(1)



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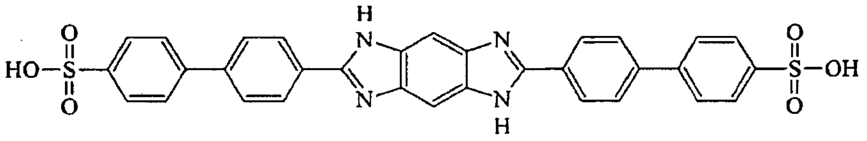

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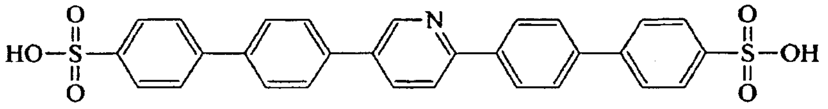

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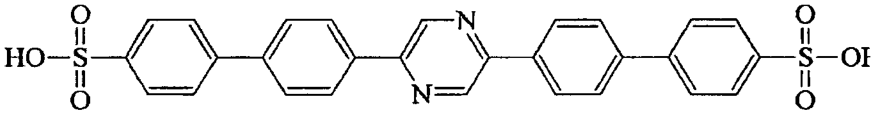

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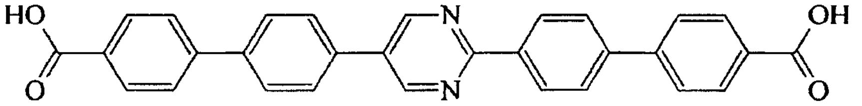

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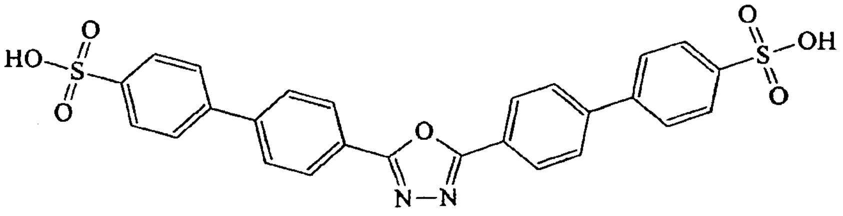

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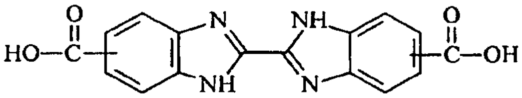

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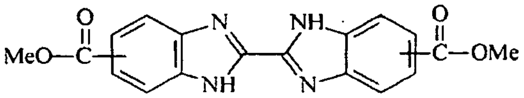

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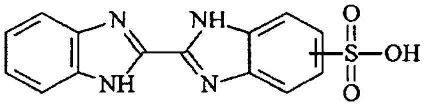

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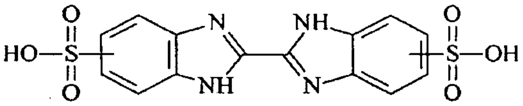

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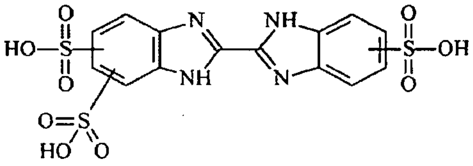

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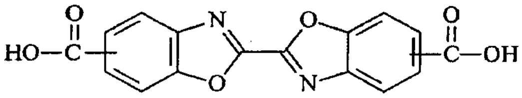

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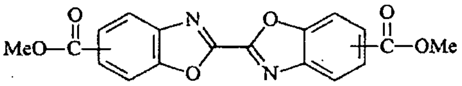

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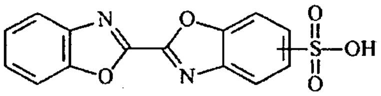

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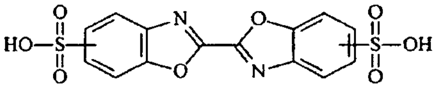

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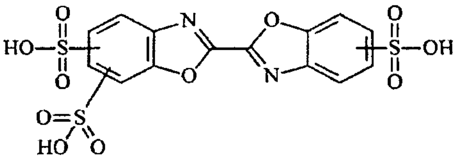

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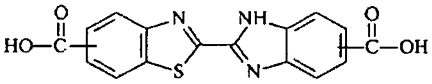

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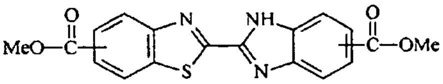

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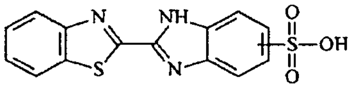

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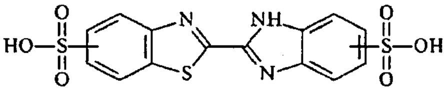

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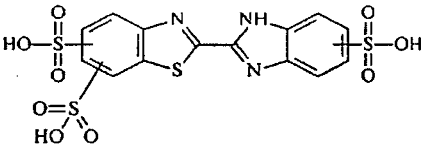

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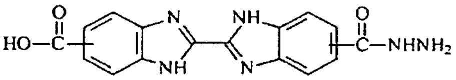

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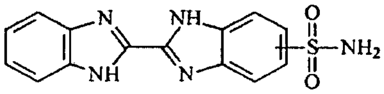

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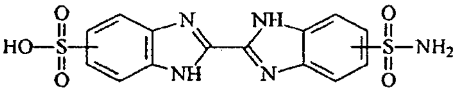

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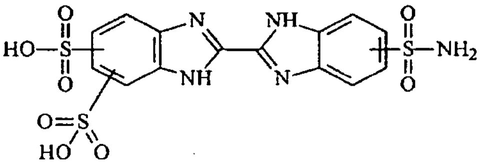

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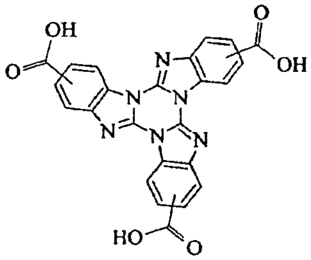

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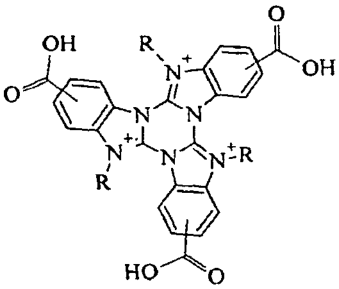
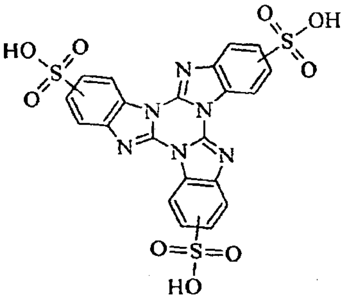


(28)

R= CH_3, C_2H_5, C_3H_7, C_4H_9



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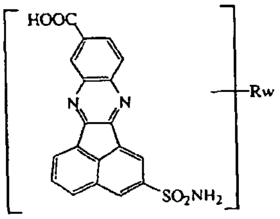

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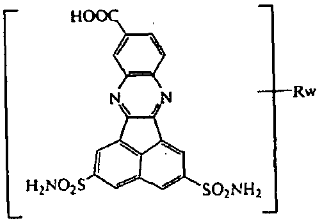

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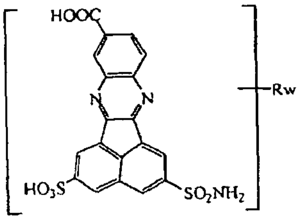

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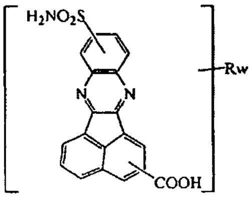

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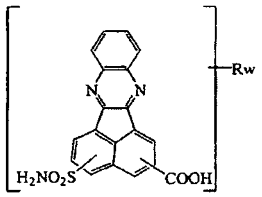

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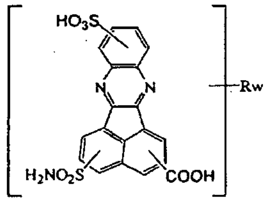

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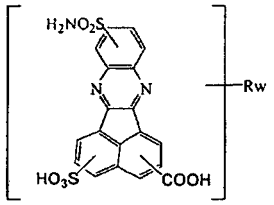

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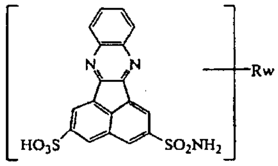

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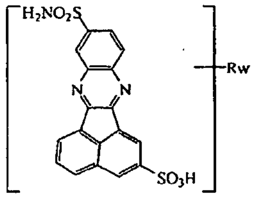

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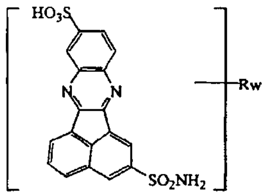

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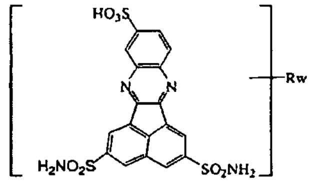

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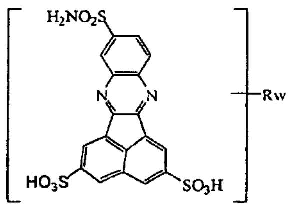

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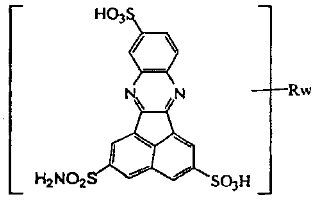

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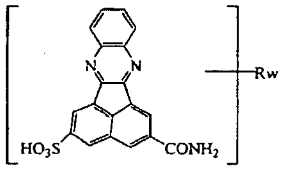

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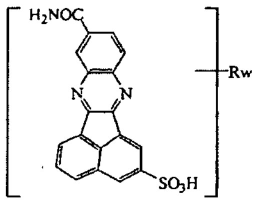

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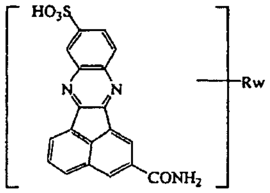

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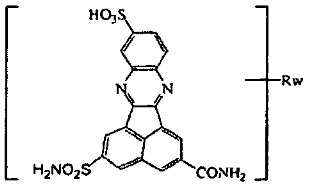

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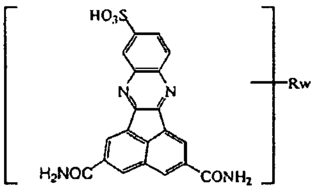

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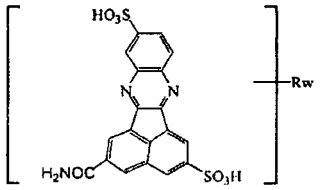

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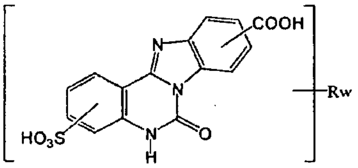

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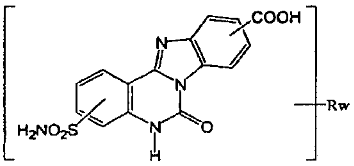

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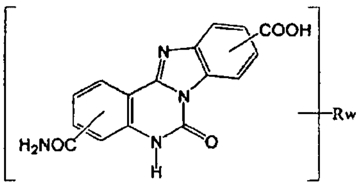

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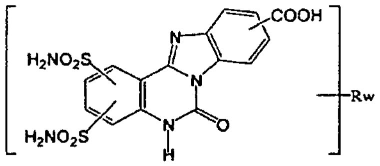

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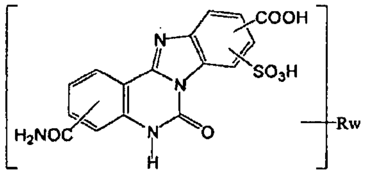

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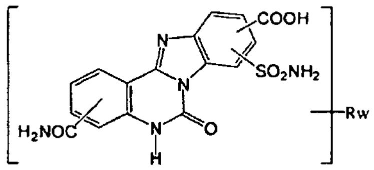

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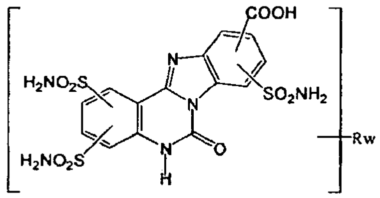

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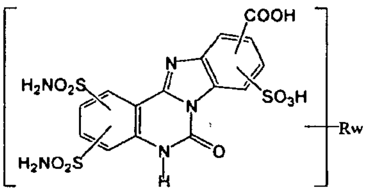

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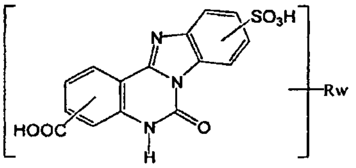

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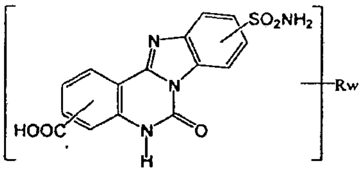

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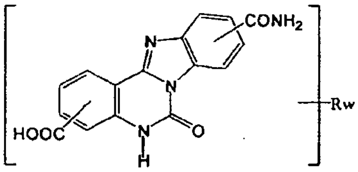

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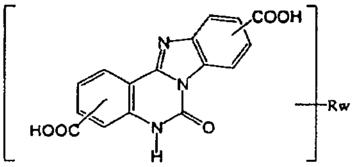

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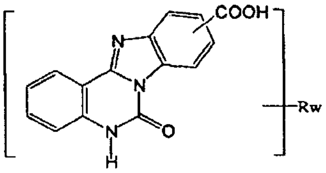

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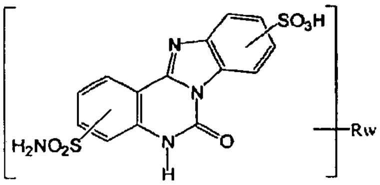

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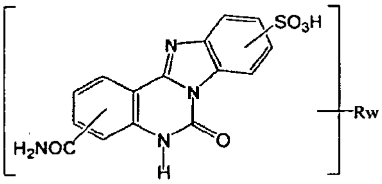

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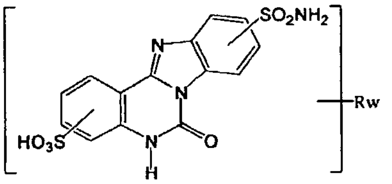

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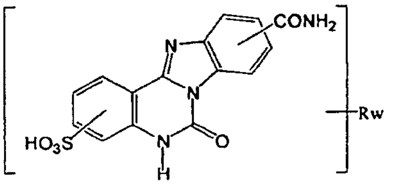

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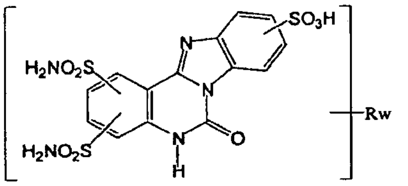

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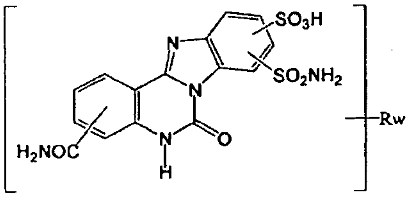

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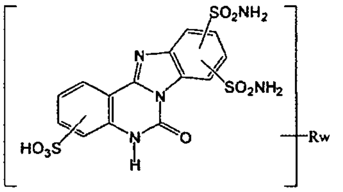

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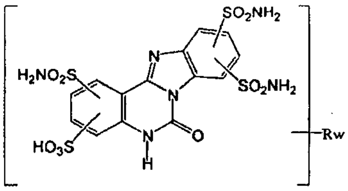

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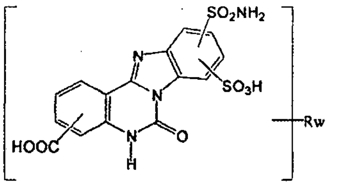


(70)

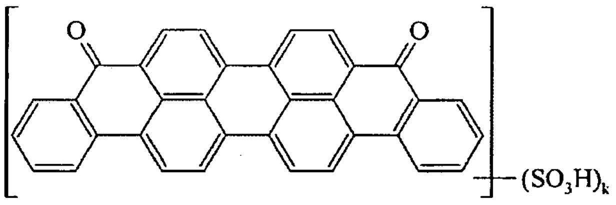
wobei R ein Substituent ist, ausgewählt aus der Liste, die CH_3, C_2H_5, Cl, Br, NO_2, F, CF_3, CN, OH, CH_3, OC_2H_5, $OCOCH_3$, OCN, SCN, NH_2 und $NHCOCH_3$ aufweist, und *w* 0, 1, 2, 3 oder 4 ist,
wobei Me eine Methylgruppe ist.

7. Eine optisch anisotrope Ausgleichsplatte gemäß eines der Ansprüche 1 bis 6, wobei die anisotrope Wirts-Matrix optische Eigenschaften besitzt, die ausgewählt sind aus der Liste, die

a) biaxiale Eigenschaften des B_A-Typs mit einer Differenz in der Bezugsebene der Brechungskoeffizienten $\Delta_{in,h}(\lambda)= |\ n_{y,h}(\lambda)-\ n_{x,n}(\lambda)$ I und/oder einer Differenz außerhalb der Bezugsebene der Brechungskoeffizienten $\Delta_{out,h}\ (\lambda) = |\ n_{x,h}(\lambda) - n_{z,n}(\lambda)\ |$ aufweist;
b) einaxiale Eigenschaften des positiven A-Typs mit einer Differenz in der Bezugsebene der Brechungskoeffizienten $\Delta_{in,h}(\lambda) = |n_{y,h}(\lambda) - n_{x,h}(\lambda)|$ aufweist;
c) einaxiale Eigenschaften des negativen A-Typs mit einer Differenz in der Bezugsebene der Brechungskoeffizienten $\Delta_{in,h}(\lambda) = |\ n_{y,h}(\lambda) - n_{x,n}(\lambda)\ |$ aufweist;
d) biaxiale Eigenschaften des Ac-Typs mit einer Differenz in der Bezugsebene der Brechungskoeffizienten $\Delta_{in,h}(\lambda)= |\ n_{y,h}(\lambda)-\ n_{x,h}(\lambda)$ I und/oder einer Differenz außerhalb der Bezugsebene der Brechungskoeffizienten Δout,h (λ) = I nx,h(λ) - nz,h(λ) | aufweist;
e) einaxiale Eigenschaften des positiven C-Typs mit einer Differenz außerhalb der Bezugsebene der Brechungskoeffizienten $\Delta_{out,h}$ (λ) = | ny,h(λ) - $n_{z,h}(\lambda)$ | aufweist; und
f) einaxiale Eigenschaften des negativen C-Typs mit einer Differenz außerhalb der Bezugsebene der Brechungskoeffizienten $\Delta_{out,h}\ (\lambda) = |\ n_{y,h}(\lambda) - n_{z,h}(\lambda)\ |$ aufweist;

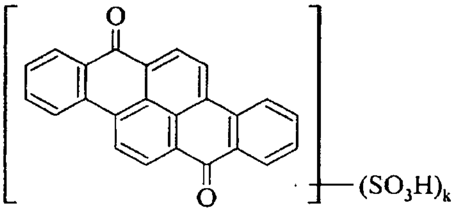
wobei für a) bis f) die Bedingung $\partial\Delta_{out,h}(\lambda)/\partial\lambda <0$ und/oder die Bedingung $(\partial\Delta_{in,h}(\lambda)/\partial\lambda$ im sichtbaren Spektralbereich erfüllt sind.

8. Eine optisch anisotrope Ausgleichsplatte gemäß eines der Ansprüche 1 bis 7, wobei die Gastpartikel eine generelle Strukturformel haben, die einer der Strukturen 71 bis 79 entspricht:



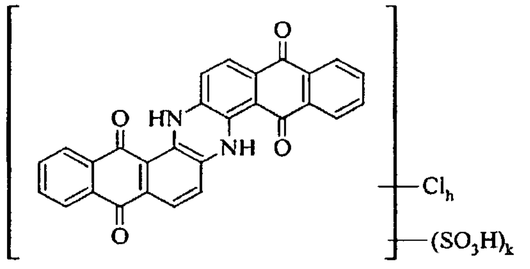
(71)

k=1,2,3,4



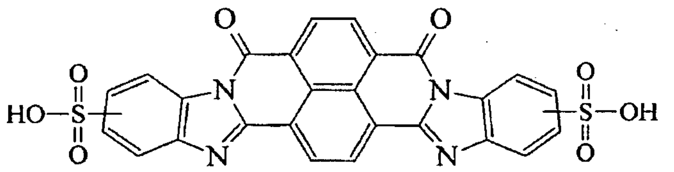
(72)

k=1,2,3,4



(73)

h=0,1
k=1,2,3,4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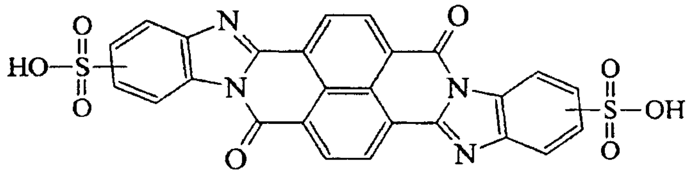
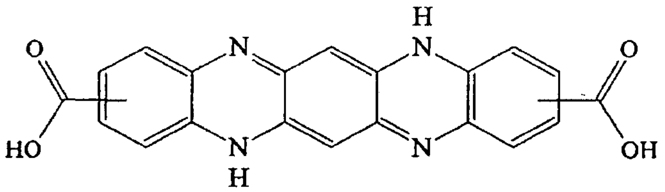

(75)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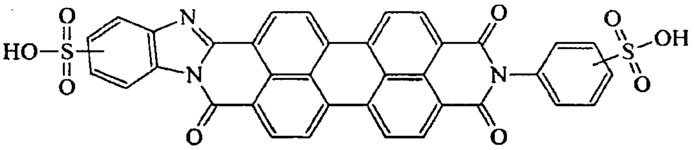
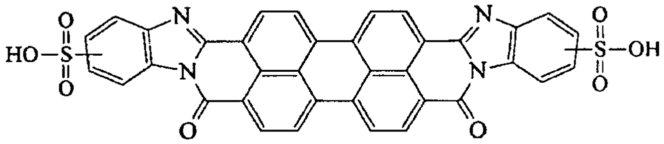
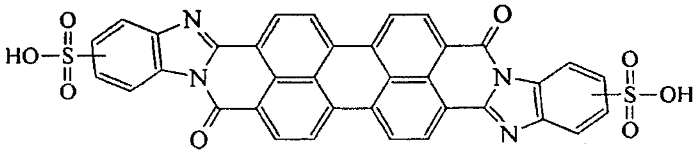

(77)


(78)


(79)

9. Eine optisch anisotrope Ausgleichsplatte gemäß Anspruch 1 bis 8, wobei das Substrat hergestellt ist aus einem oder mehreren Materialien der Gruppe, die Diamanten, Quartze, Kunststoffe, Glas, Keramik und mindestens ein Element der Gruppe der Farbfiltersubstrate, Schaltungsmerkmale, mehrstufigen Schaltungen und TFT-Array-Substrat aufweisen.

10. Eine Farbflüssigkristallanzeige,
die eine Flüssigkristallzelle (1, 57) aufweist,
einen ersten und zweiten Polarisator (12, 20, 55, 56, 72, 80), die an jeder Seite der Flüssigkristallzelle angeordnet sind, und
mindestens eine Ausgleichsplatte gemäß eines der Ansprüche 1 bis 9, die zwischen den besagten Polarisatoren positioniert ist.

11. Eine Flüssigkristallanzeige gemäß Anspruch 10, wobei die Flüssigkristallzelle eine Schaltmodus-Zelle in der Bezugsebene oder eine vertikal-ausgerichtete Modus-Zelle ist.

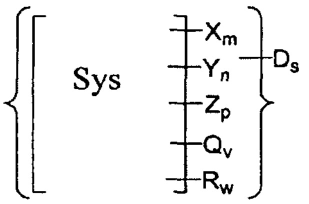
12. Eine Flüssigkristallanzeige gemäß Anspruch 10 oder 11, wobei die Ausgleichsplatte in der Flüssigkristallzelle positioniert ist.

Revendications

1. Un panneau de compensation optiquement anisotrope (13,17, 30, 64, 73, 77) comprenant au moins une couche optiquement anisotrope (14, 15, 18, 19, 35, 74, 75, 78, 79) sur un substrat, le panneau de compensation possédant une dispersion contrôlée spectralement des indices de réfraction,
dans lequel la couche est basée sur un système invité-hôte ordonné comprenant:

    une matrice hôte anisotrope ordonnée (90) comprenant un composé organique transparent au rayonnement électromagnétique dans la plage du spectre de lumière visible et présentant trois indices de réfraction principaux ($n_{x,h}$, $n_{y,h}$ et $n_{z,h}$) possédant une dispersion spectrale normale $\partial n_u(\lambda)/\partial\lambda < 0$ dans la plage du spectre de lumière visible, dans laquelle l'indice est sélectionné dans la liste comprenant x, y et z ; et
    un élément hôte ordonné (91) comprenant des particules hôtes, les particules hôtes étant des molécules de colorant optiquement anisotropes qui fournissent une absorption supplémentaire à une absorption de la matrice hôte anisotrope, réalisée dans au moins une direction principale de la matrice hôte anisotrope dans au moins une sous-plage de la plage du spectre de lumière visible, telle que la couche optiquement anisotrope présente trois indices de réfraction principaux (n_x, n_y et n_z), au moins un desquels satisfait la condition suivante dans laquelle $\partial n_u(\lambda)/\partial\lambda \geq 0$ dans au moins une sous-plage de la plage du spectre de lumière visible et dans laquelle l'indice u est sélectionné dans la liste comprenant x, y et z.

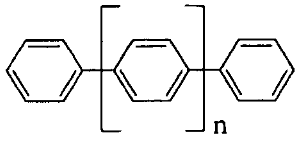
2. Un panneau de compensation optiquement anisotrope selon la revendication 1, dans lequel le composé organique pour la matrice hôte présente une formule structurale générale I



$$\left\{ \left[\mathrm{Sys} \right] \begin{array}{l} -X_m \\ -Y_n \\ -Z_p \\ -Q_v \\ -R_w \end{array} \right\} -D_s$$

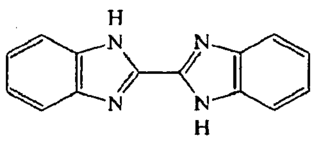
, (I)

dans laquelle Sys est un système moléculaire polycyclique au moins partiellement conjugué présentant une formule structurale générale en provenance de la liste comprenant des structures II à XLVI :

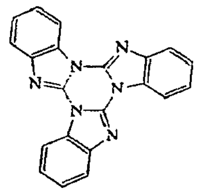


(II)

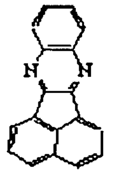
dans laquelle n est un nombre dans la plage de 1 à 8



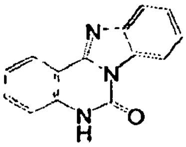
(III)



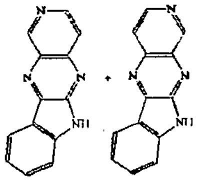
(IV)



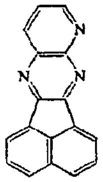
(V)



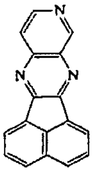
(VI)



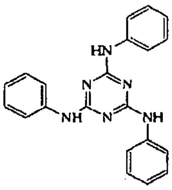
(VII)



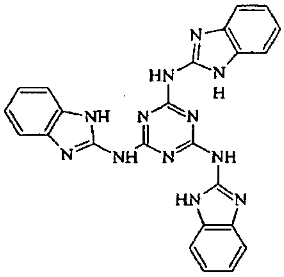
(VIII)



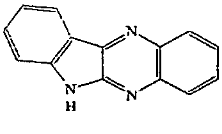
(IX)



(X)



(XI)



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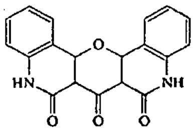

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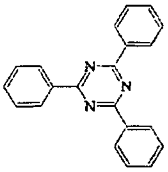

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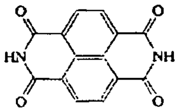

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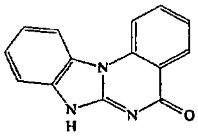
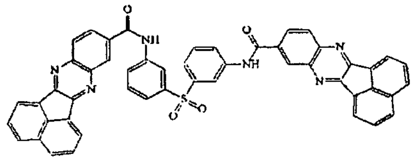


(XVI)



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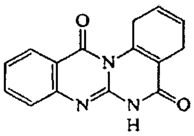

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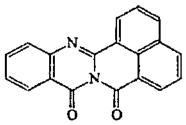

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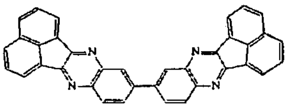
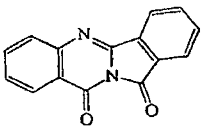
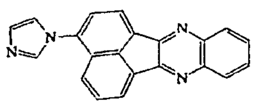


(XX)



(XXI)



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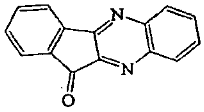

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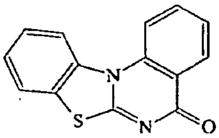

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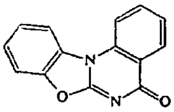

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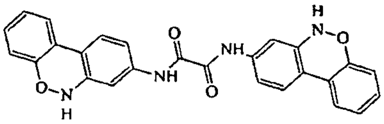

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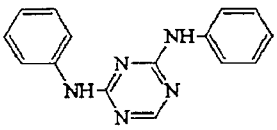

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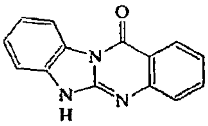

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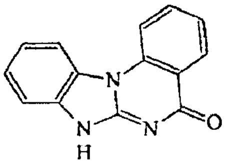

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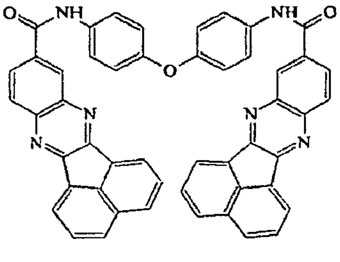
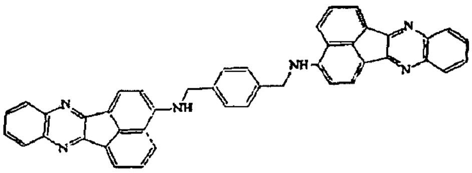


(XXX)



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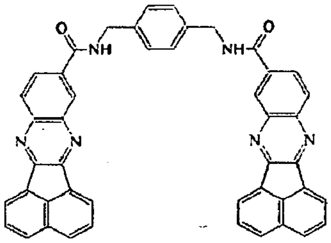

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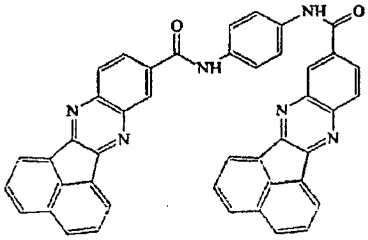

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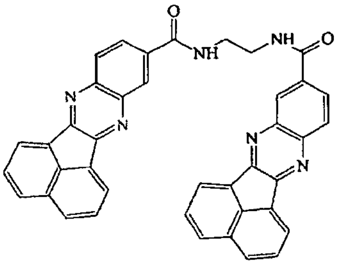

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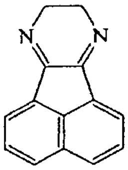

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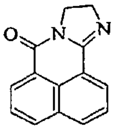

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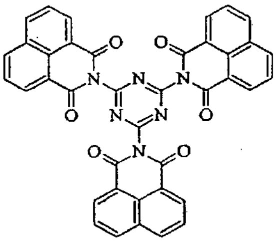

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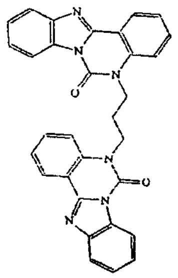

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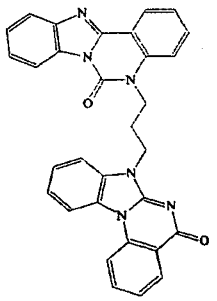

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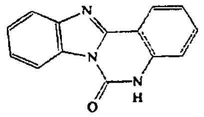
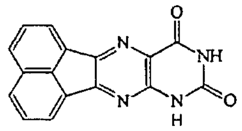
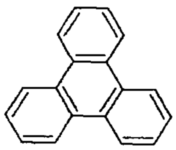


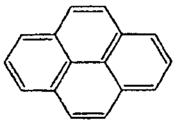
(XL)



(XLI)



(XLII)



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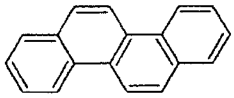
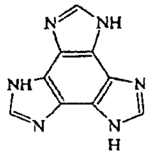


(XLIV)



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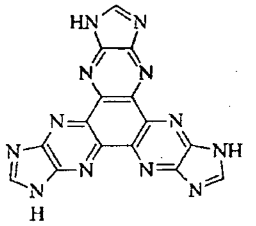


(XLVI)

et

X est un groupe carboxylique -COOH, *m* est 0, 1, 2, 3 ou 4 ; Y est un groupe sulfonique - SO_3H, n est 0, 1, 2, 3 ou 4 ; Z est un carboxamide, p est 0, 1, 2, 3 ou 4 ; q est un sulfonamide, v est 0, 1, 2, 3 ou 4 ; D est un contre-ion ; *s* est le nombre de contre-ions fournissant un état électriquement neutre de la molécule ; R est un substituant sélectionné dans la liste comprenant CH_3, C_2H_5, Cl, Br, NO_2, F, FC_3, CN, OH, CH_3, OC_2H_5, $OCOCH_3$, OCN, SCN, NH_2 et $NHCOCH_3$ et w est de 0, 1, 2, 3 ou 4.

3. Un panneau de compensation optiquement anisotrope selon une quelconque des revendications 1 ou 2, dans lequel la couche optiquement anisotrope possède les propriétés optiques sélectionnées à partir :

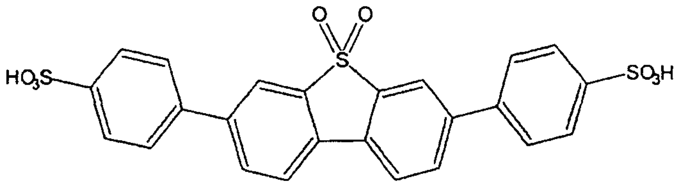
(a) des propriétés biaxiales de type BA ($n_y > n_z > n_x$ ou $n_x > n_z > n_y$ dans la plage du spectre de lumière visible), des propriétés uniaxiales de type A négatif, les propriétés uniaxiales de type A positif ou les propriétés biaxiales de type A_C ($n_y > n_x > n_z$ ou $n_x > n_y > n_z$ (type A_C positif) ou $n_y < n_x < n_z$ or $n_x < n_y < n_z$ (type A_C négatif)), dans lequel chacun parmi les types B_A, types A négatif, types A positif et types Ac-est **caractérisé par** une différence dans le plan des indices de réfraction $\Delta_{in}(\lambda) = | n_o(\lambda) - n_x(\lambda) |$, lequel satisfait la condition $\partial\Delta_{in}(\lambda)/ \partial\Delta\geq0$ dans au moins une sous-plage de la plage du spectre de lumière visible ; et

(b) des propriétés biaxiales de type B_A, des propriétés biaxiales de type Ac, des propriétés uniaxiales de type C négatif ou des propriétés uniaxiales de type C positif, dans lequel chacun parmi les types B_A, types Ac, types C négatif et types C positif est **caractérisé par** une différence hors plan des indices de réfraction $\Delta_{out}(\lambda) = | n_z(\lambda) - n_x(\lambda) |$ et chacun parmi les types B_A et type Ac est également **caractérisé par** une différence dans le plan des indices de réfraction $\Delta_{in}(\lambda) = | n_y(\lambda) - n_x(\lambda) |$, dans lequel la condition $\Delta_{out}(\lambda)/\partial\lambda\geq0$ ou la condition $\partial\Delta_{out}(\lambda)/\partial\lambda\geq0$ et $\partial\Delta_{in}(\lambda)/\partial\lambda\geq0$ est satisfaite dans au moins une sous-plage de longueur d'onde de la plage du spectre de lumière visible.

4. Un panneau de compensation optiquement anisotrope selon la revendication 3, dans lequel la différence dans le plan des indices de réfraction $\Delta_{in}(\lambda)$ obéit à la condition suivante : les facteurs de dispersion spectrale ($\Delta_{in,450}/\Delta_{in,550}$) et ($\Delta_{in,550}/\Delta_{in,650}$) sont dans une plage de 0,4 à 1,0 et dans lesquels la différence hors plan des indices de réfraction $\Delta_{out}(\lambda)$ obéit à la condition suivante : les facteurs de dispersion spectrale ($\Delta_{out,450}/\Delta_{out,550}$) et ($\Delta_{out,550}/ \Delta_{out,650}$) sont dans une plage de 0,4 à 1,0, dans lequel $\Delta_{in,450}$, $\Delta_{in,550}$ et $\Delta_{in,650}$ sont des valeurs des différences dans le plan des indices de réfraction et $\Delta_{out,450}$, $\Delta_{out,550}$ et $\Delta_{out,650}$ sont des valeurs des différences hors plan des indices de réfraction $\Delta_{out}(\lambda)$ à des longueurs d'onde de 450 nm, 550 nm et 650 nm respectivement.

5. Un panneau de compensation optiquement anisotrope selon une quelconque des revendications 2 à 4, dans lequel le contre-ion est sélectionné dans la liste comprenant H^+, NH_4^+, Na^+, K^+, Li^+, Ba^{++}, Ca^{++}, Mg^{++}, Sr^{++}, Cs^+, PB^{++} et Zn^{++}.

6. Un panneau de compensation optiquement anisotrope selon une quelconque des revendications 1 à 5, dans lequel le composé organique présente une formule structurale générale correspondant à l'une des structures de 1 à 70 :



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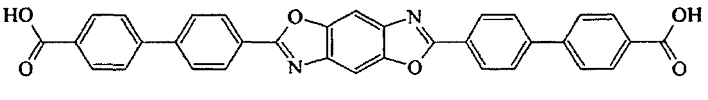

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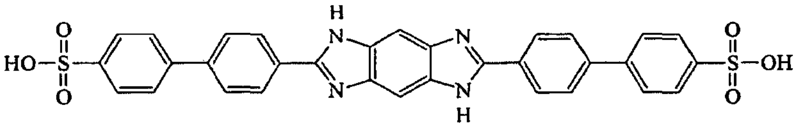

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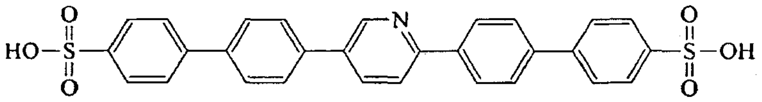

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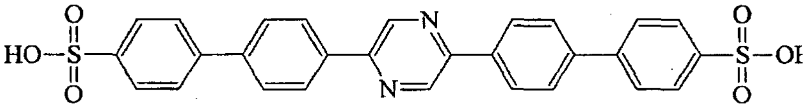

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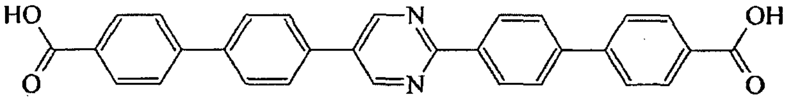

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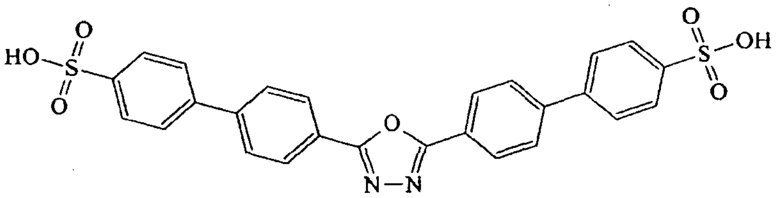

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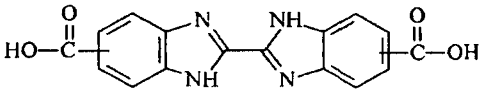

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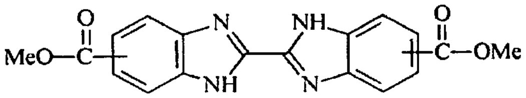

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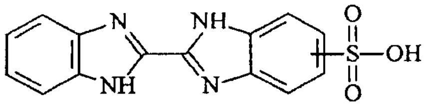

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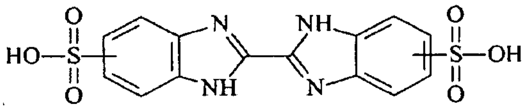

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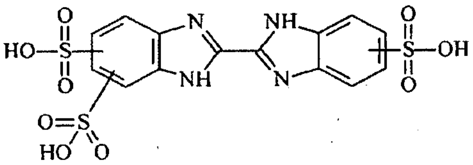

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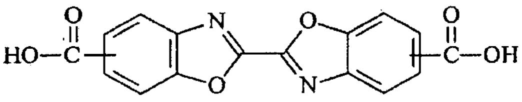
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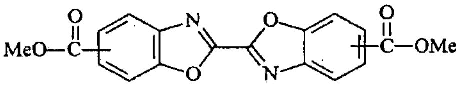
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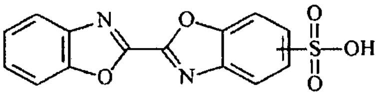
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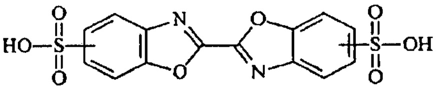
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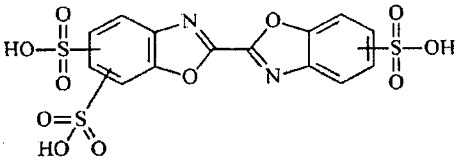
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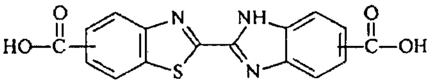
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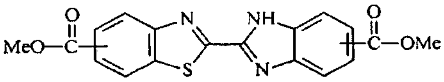
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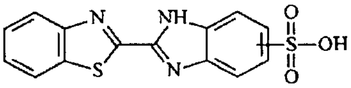
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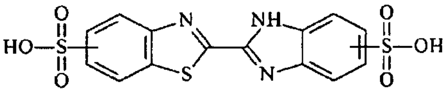
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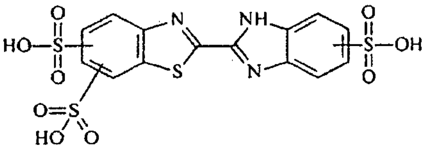
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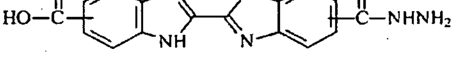
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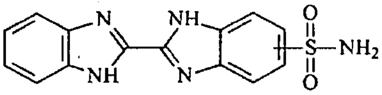
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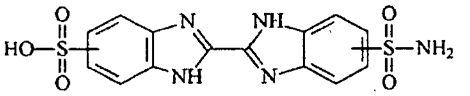

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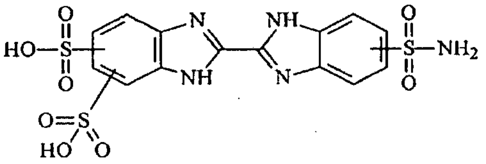

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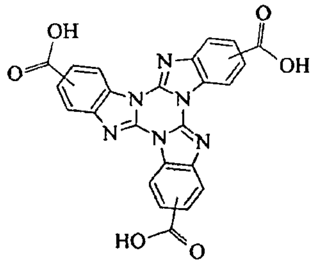

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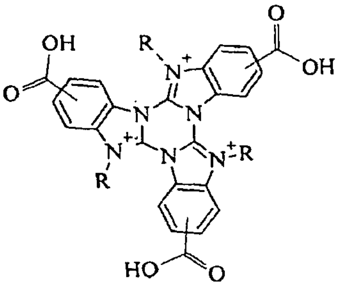

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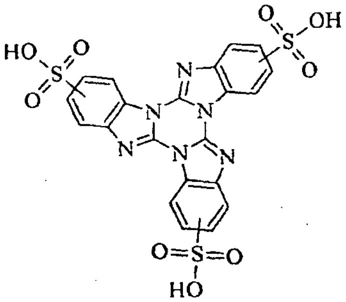
R= CH_3, C_2H_5, C_3H_7, C_4H_9



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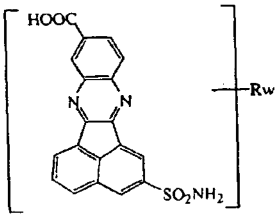

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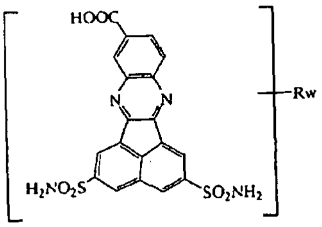

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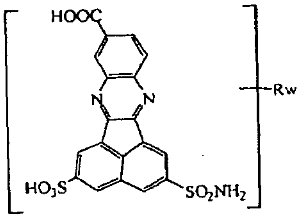

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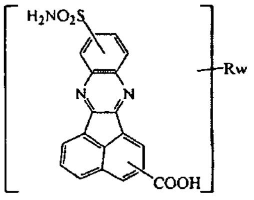

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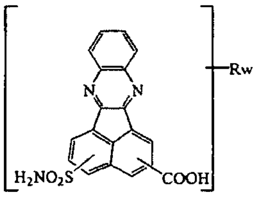

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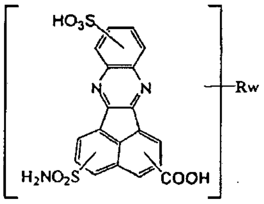

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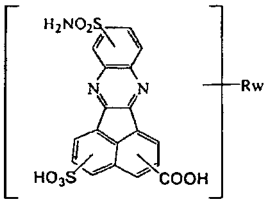

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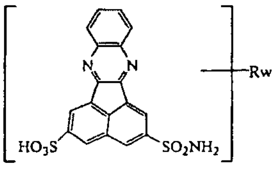

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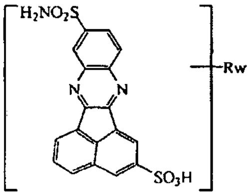

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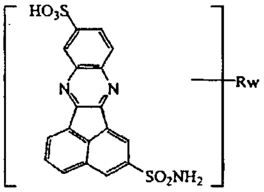

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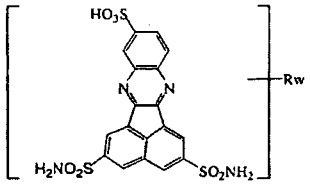

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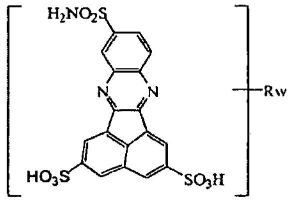

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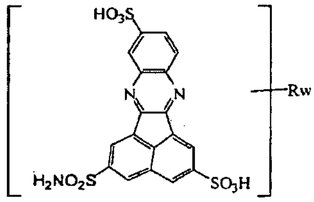

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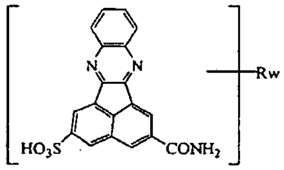

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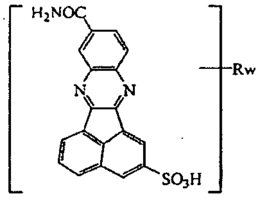

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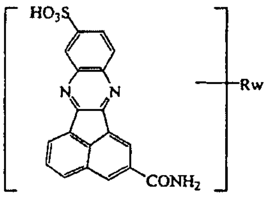

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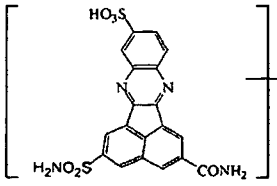

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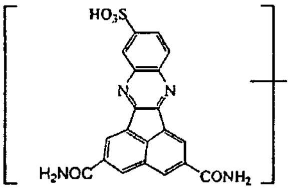

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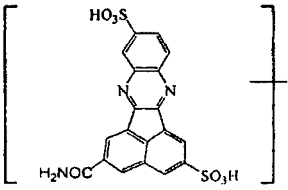

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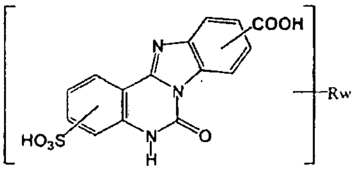

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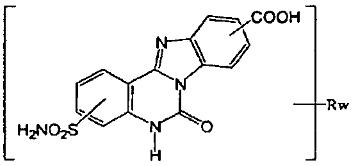

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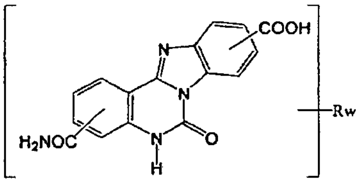

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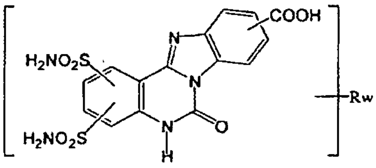

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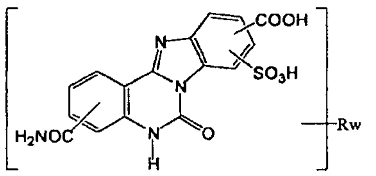

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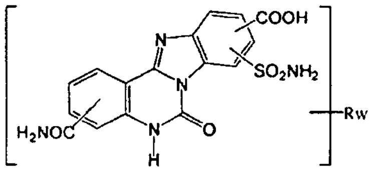

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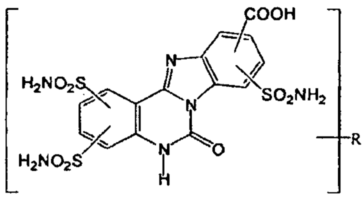

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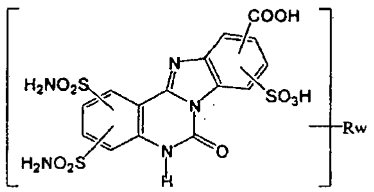

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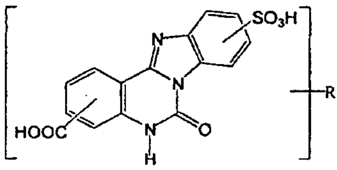

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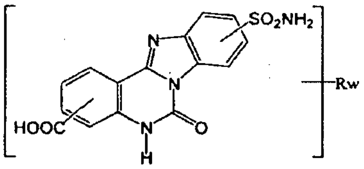

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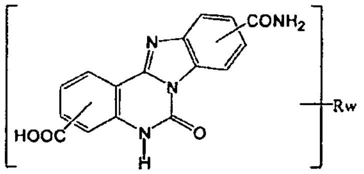

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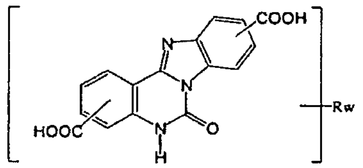

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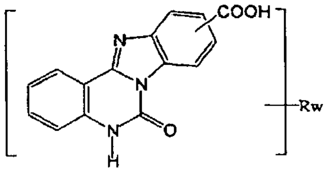

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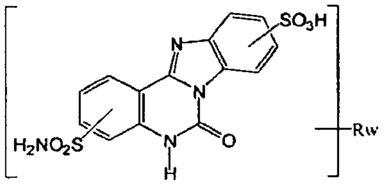
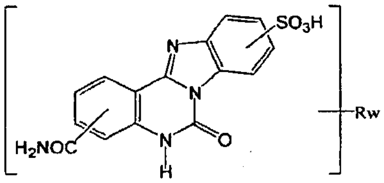
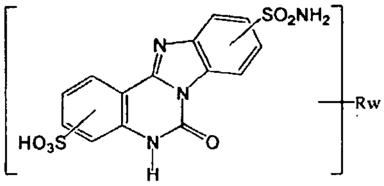


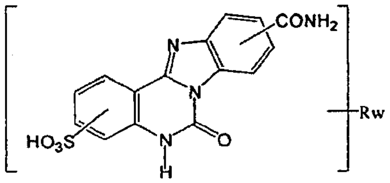
(62)



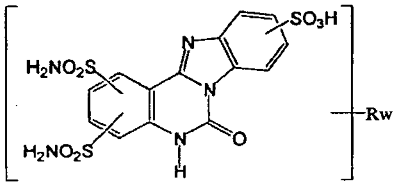
(63)



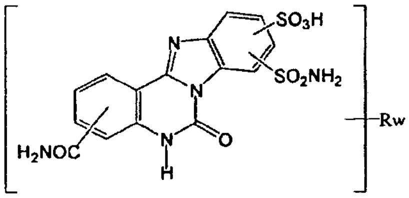
(64)



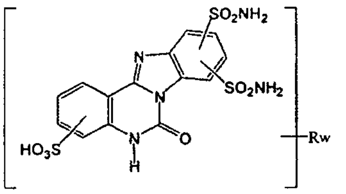
(65)



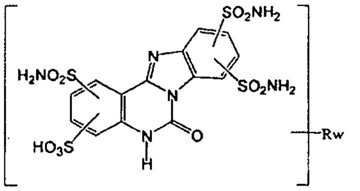
(66)



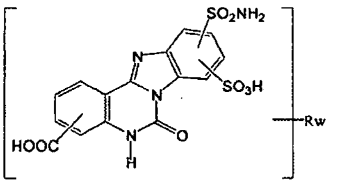
(67)



(68)



(69)



(70)

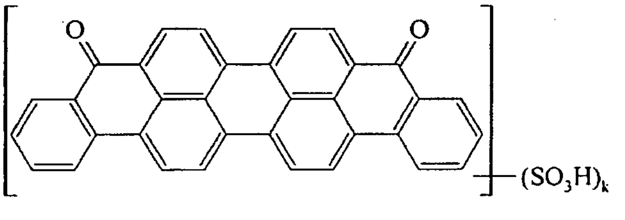
dans lequel, R est un substituant sélectionné dans la liste comprenant CH_3, C_2H_5, Cl, Br, NO_2, F, FC_3, CN, OH, CH_3, OC_2H_5, $OCOCH_3$, OCN, SCN, NH_2 et $NHCOCH_3$ et w est 0, 1, 2, 3 ou 4,
dans lequel, Me est un groupe méthyle.

7. Un panneau de compensation optiquement anisotrope selon une quelconque des revendications 1 ou 6, dans lequel la matrice hôte anisotrope possède les propriétés optiques sélectionnées dans la liste comprenant :

a) les propriétés biaxiales de type B_A présentant une différence dans le plan des indices de réfraction $\Delta_{in,h}(\lambda)= | n_{y,h}(\lambda)-n_{x,n}(\lambda) I$ et/ou une différence hors plan des indices de réfraction $\Delta_{out,h}(\lambda) = | n_{x,h}(\lambda) - n_{z,n}(\lambda) |$;
b) les propriétés uniaxiales de type A positif présentant une différence dans le plan des indices de réfraction $\Delta_{in,h}(\lambda) = | n_{y,h}(\lambda) - n_{x,h}(\lambda) |$;
c) les propriétés uniaxiales de type A négatif présentant une différence dans le plan des indices de réfraction $\Delta_{in,h}(\lambda) = | n_{y,h}(\lambda) - n_{x,h}(\lambda)|$;
d) les propriétés biaxiales de type Ac présentant une différence dans le plan des indices de réfraction $\Delta_{in,h}(\lambda) = | n_{y,h}(\lambda) - n_{x,h}(\lambda) |$ et/ou une différence hors plan des indices de réfraction $\Delta_{out,h}(\lambda) = | n_{x,h}(\lambda) - n_{z,h}(\lambda) |$;
e) les propriétés uniaxiales de type C positif présentant une différence hors plan des indices de réfraction $\Delta_{out,h}(\lambda) = | n_{x,h}(\lambda) - n_{z,h}(\lambda) |$;et
f) les propriétés uniaxiales de type C négatif présentant une différence hors plan des indices de réfraction $\Delta_{out,h}(\lambda) = | n_{x,n}(\lambda) - n_{z,h}(\lambda) |$;

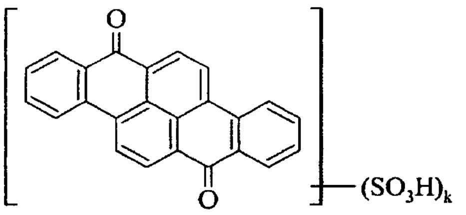
dans lequel pour chaque condition a) à f) $\partial\Delta_{out,h}(\lambda)/\partial\lambda < 0$ et/ou à la condition $(\partial\Delta_{in,h}(\lambda)/\partial\lambda$ sont satisfaites dans la plage du spectre de lumière visible.

8. Un panneau de compensation optiquement anisotrope selon une quelconque des revendications 1 à 7, dans lequel les particules hôtes présentent une formule structurale générale correspondant aux structures 71 à 79 :



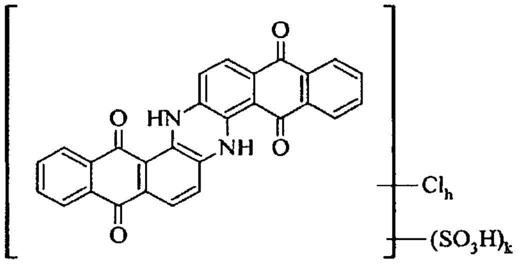
(71)

k=1,2,3,4



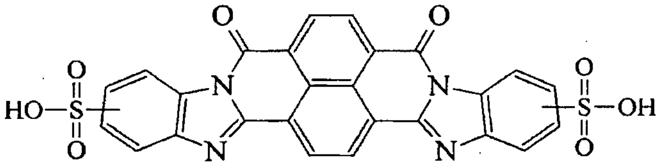
(72)

k=1,2,3,4

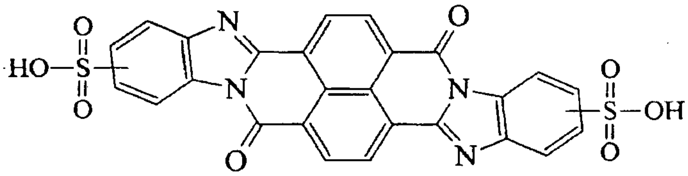


(73)

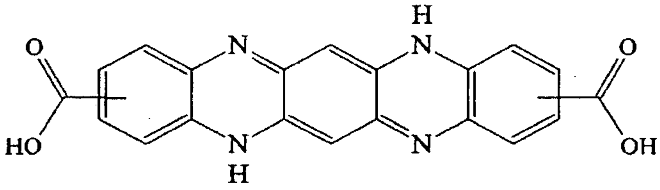
h=0,1
k=1,2,3,4



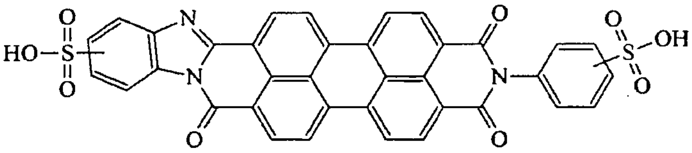
(74)



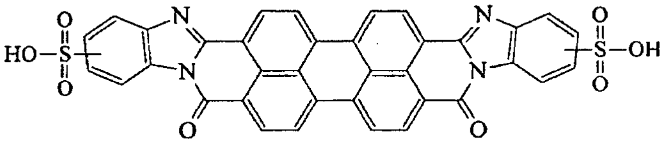
(75)



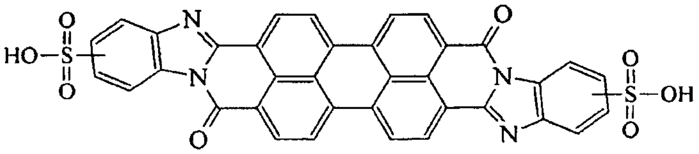
(76)



(77)



(78)


(79)

9. Un panneau de compensation optiquement anisotrope selon la revendication 1 à 8, dans lequel le substrat est constitué d'un ou plusieurs matériaux du groupe comprenant le diamant, le quartz, les matières plastiques, les verres, la céramique et comprend au moins un élément du groupe comprenant le substrat de filtre couleur, les caractéristiques de circuit, les interconnexions et le substrat de réseau à matrice active (transistors à couches minces ou TFT).

10. Un afficheur à cristaux liquides couleur
comprenant une cellule à cristaux liquides (1, 57),
un premier et un second polariseur (12, 20, 55, 56, 72, 80) disposés de chaque côté de la cellule à cristaux liquides et au moins un panneau de compensation selon une quelconque des revendications 1 à 9, situé entre lesdits polariseurs.

11. Un afficheur à cristaux liquides selon la revendication 10, dans lequel la cellule à cristaux liquides est dans un mode de commutation dans le plan ou une cellule en mode aligné verticalement.

12. Un afficheur à cristaux liquides selon la revendication 10 ou 11, dans lequel le panneau de compensation est situé à l'intérieur de la cellule à cristaux liquides.

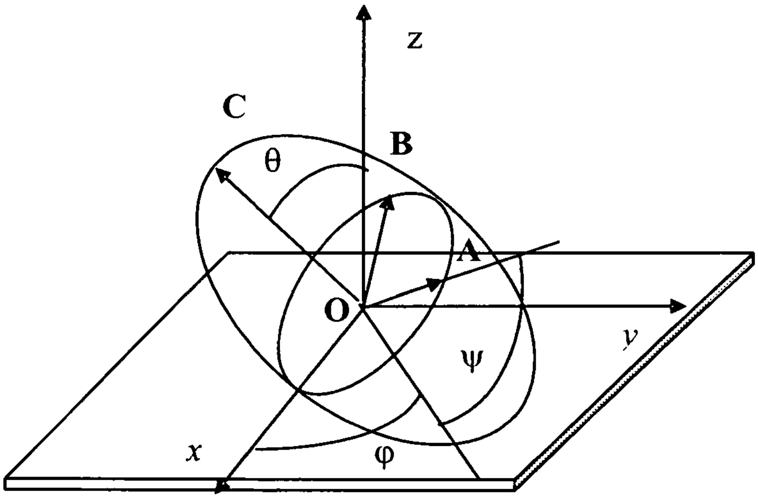


FIGURE 1
PRIOR ART

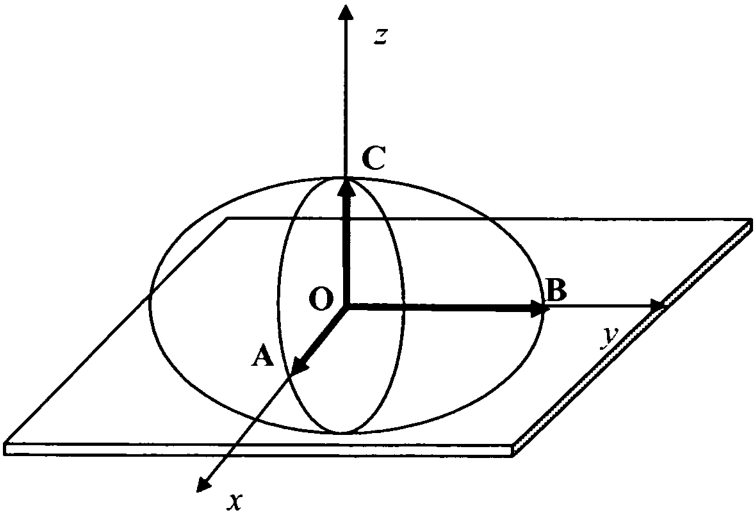
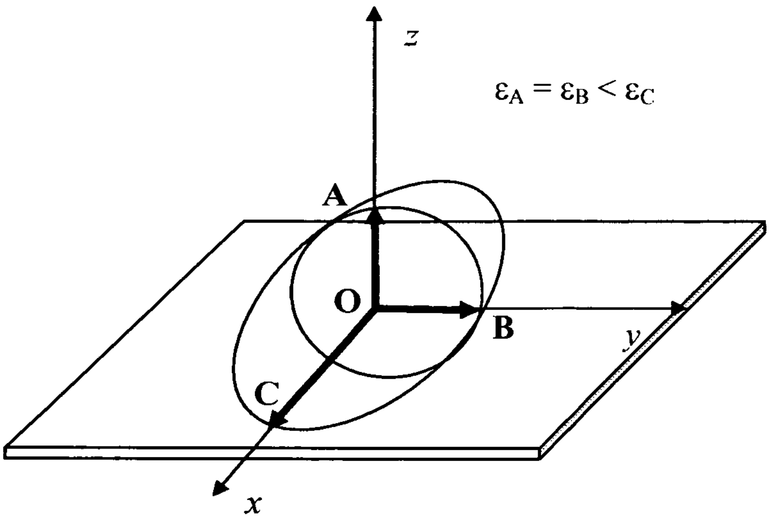
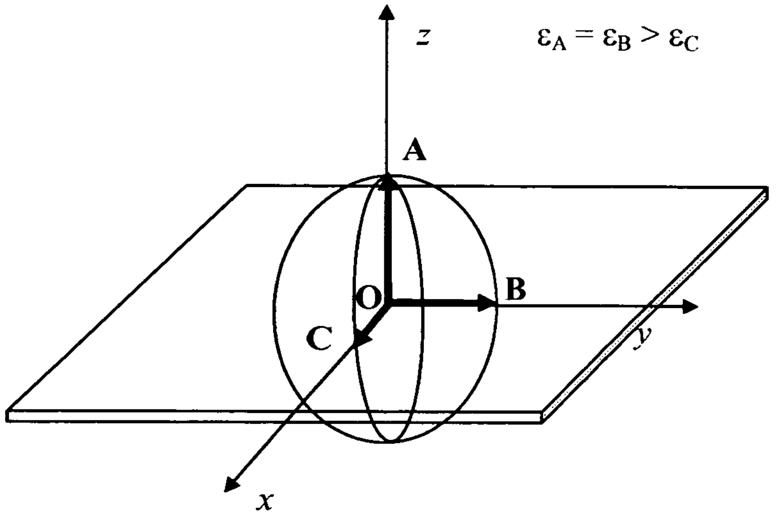


FIGURE 2
PRIOR ART



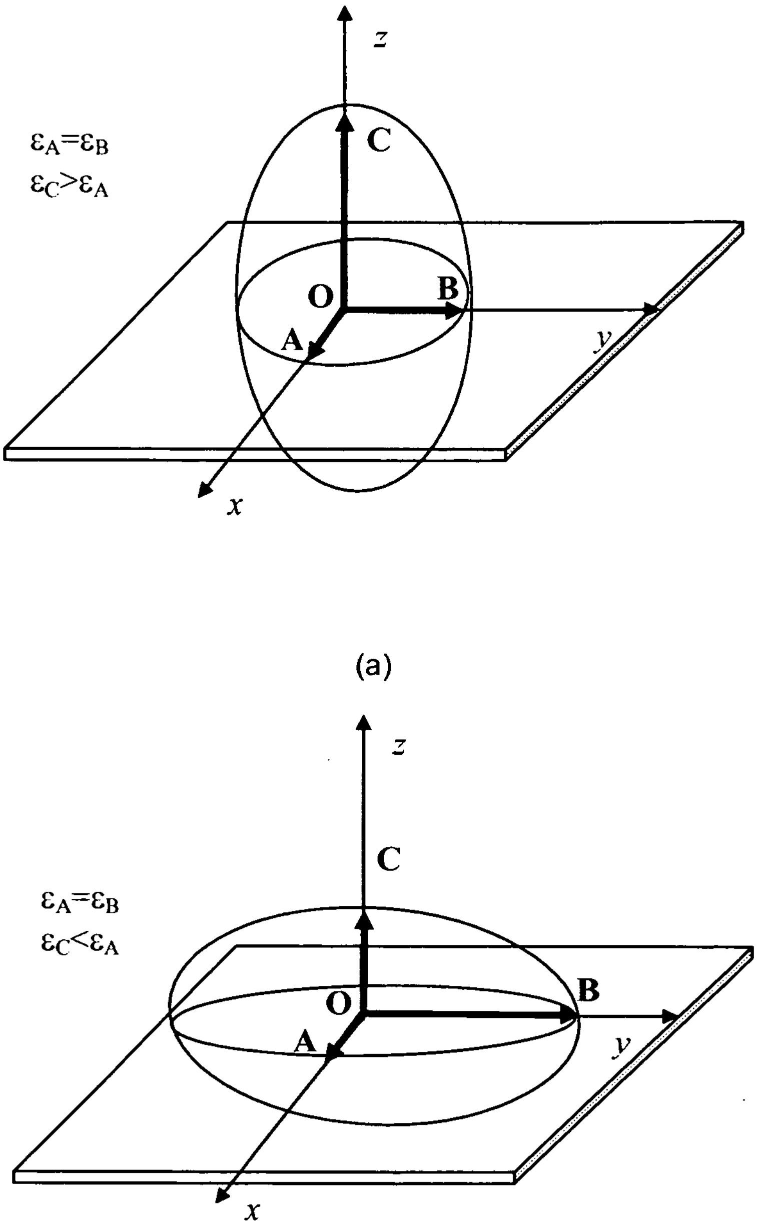
(a)



(b)

FIGURE 3

PRIOR ART



(a)

(b)

FIGURE 4
PRIOR ART

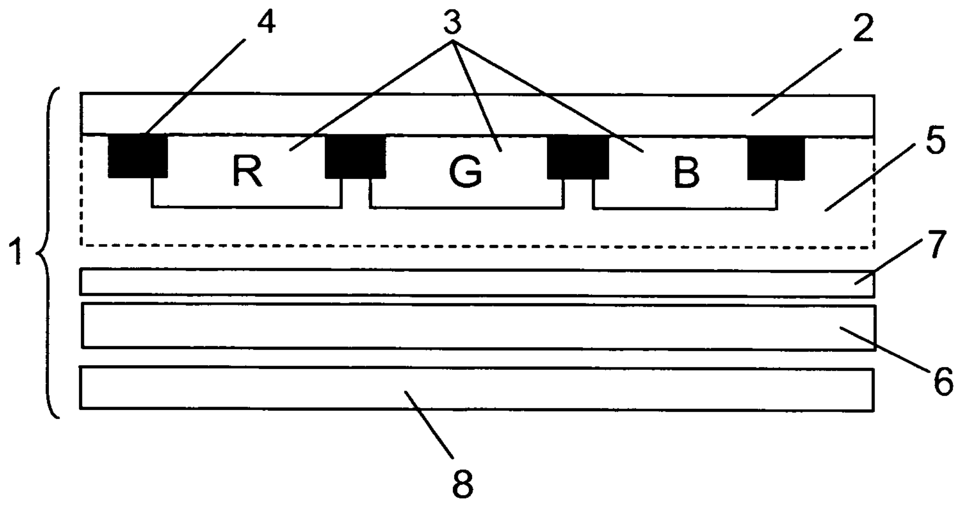


FIGURE 5
PRIOR ART

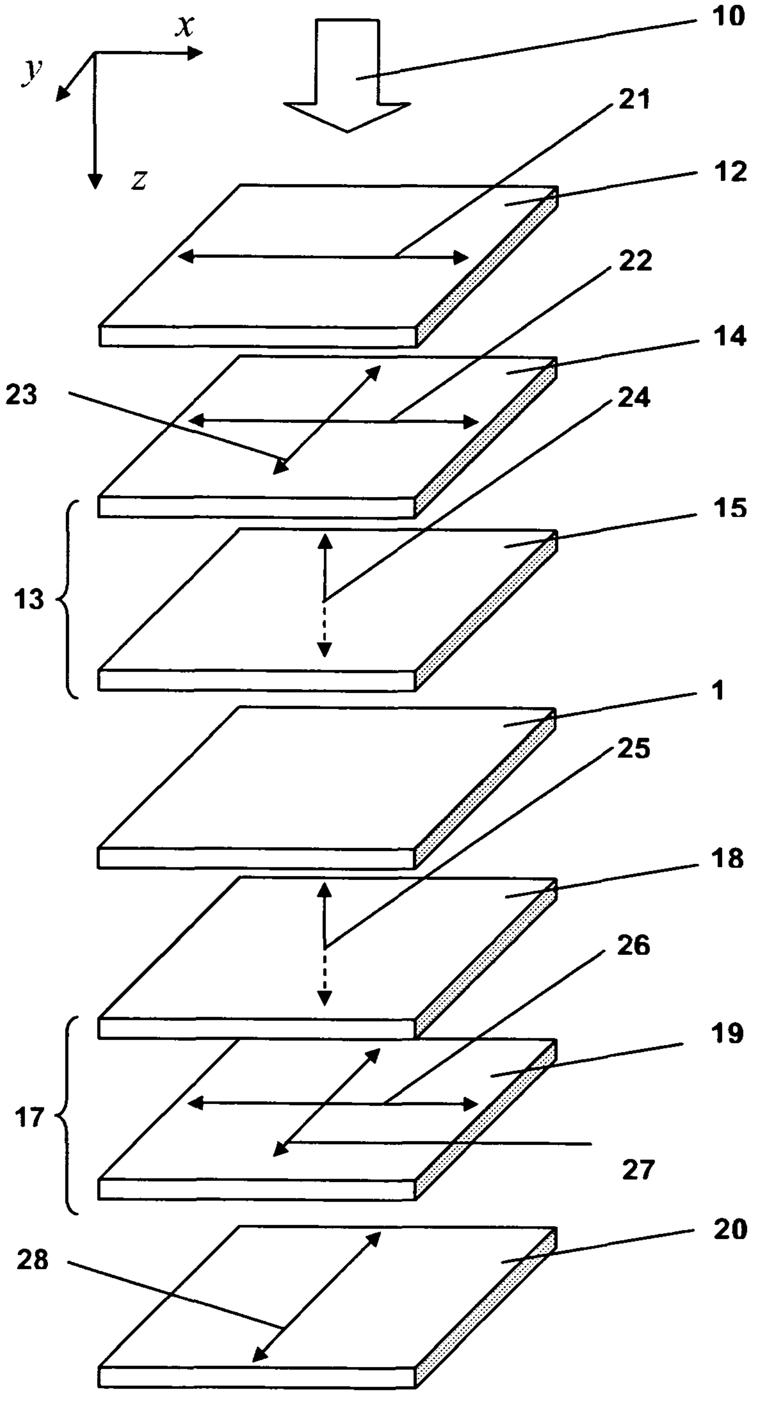


FIGURE 6

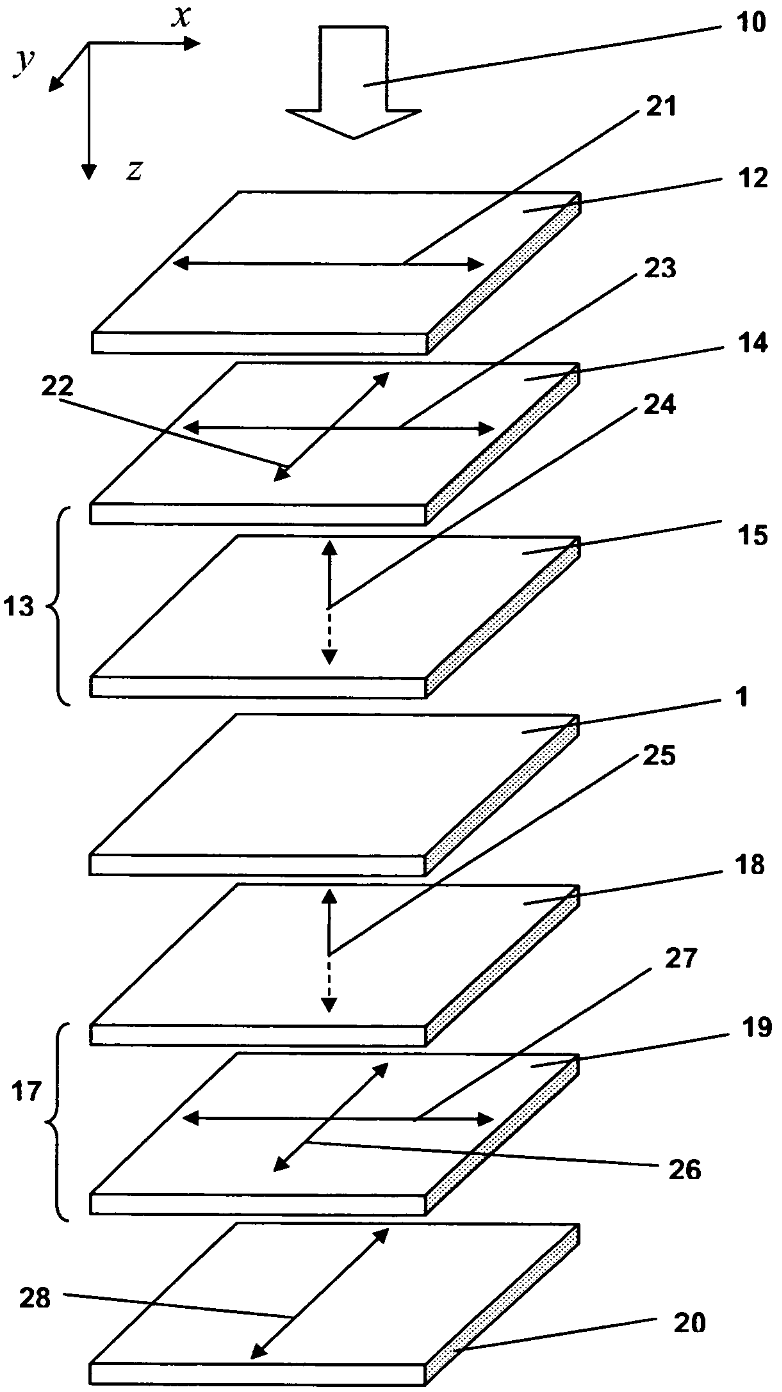


FIGURE 7

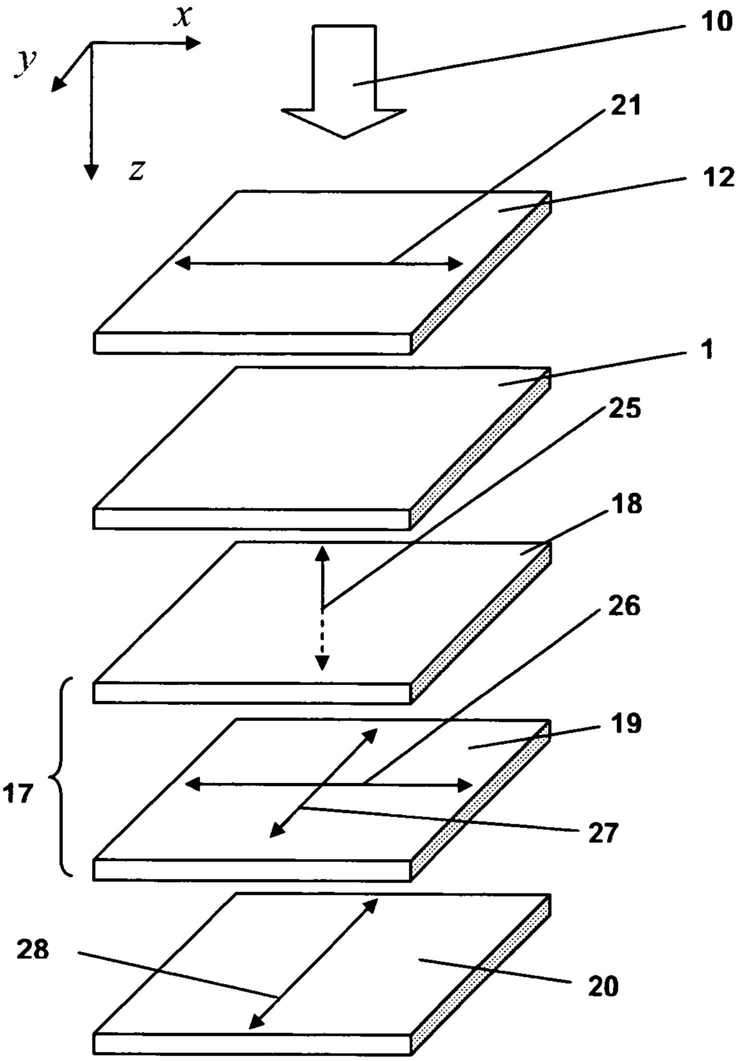


FIGURE 8

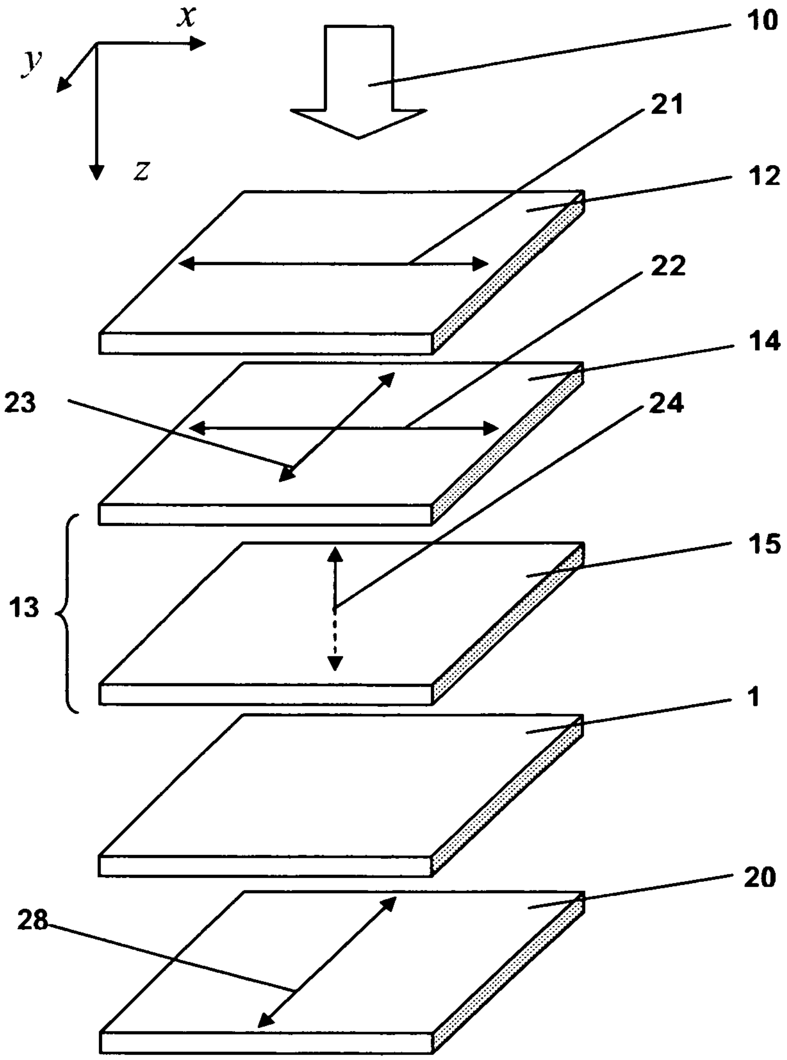


FIGURE 9

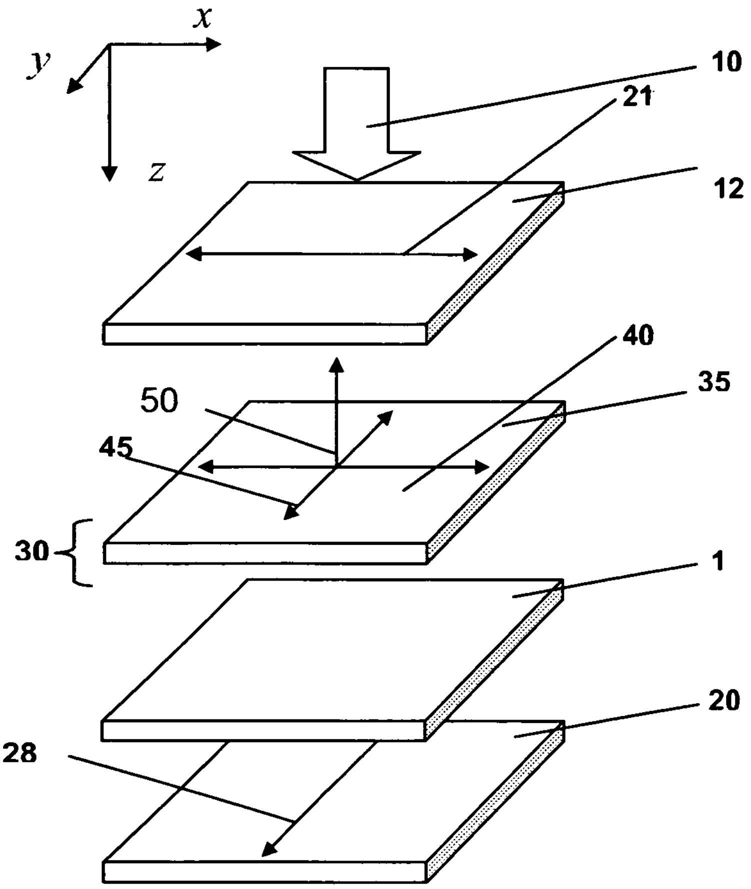


FIGURE 10

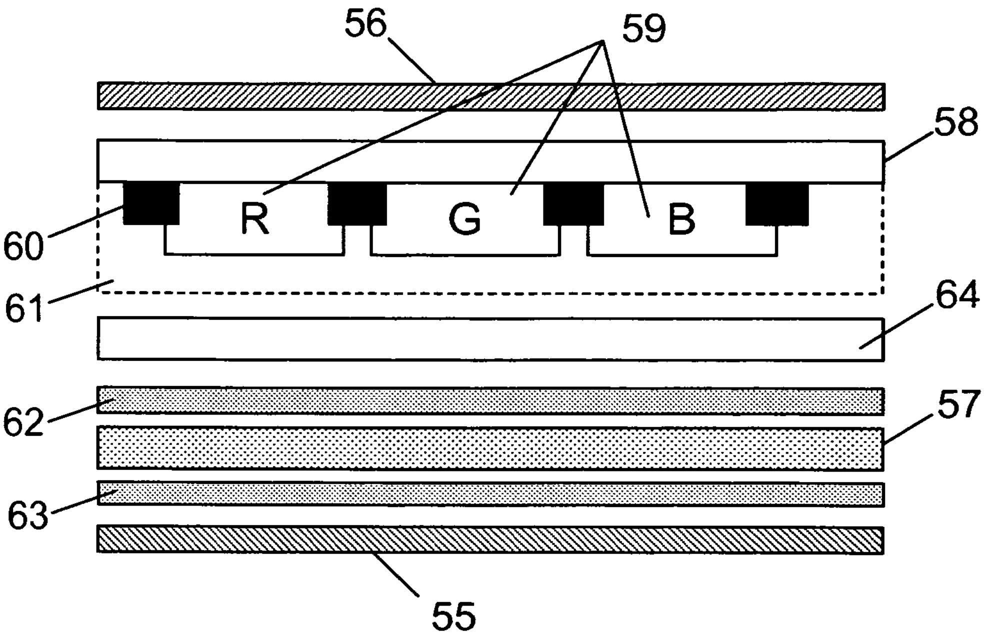


FIGURE 11

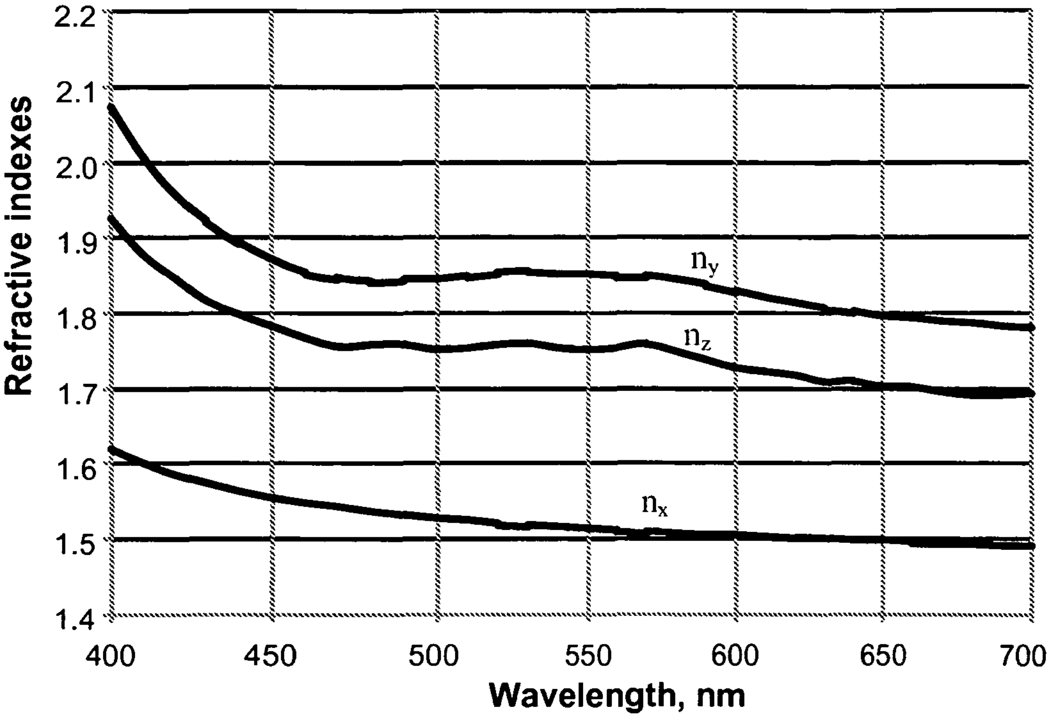

Refractive indexes
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
400
450
500
550
600
650
700
Wavelength, nm
n_y
n_z
n_x

FIGURE 12

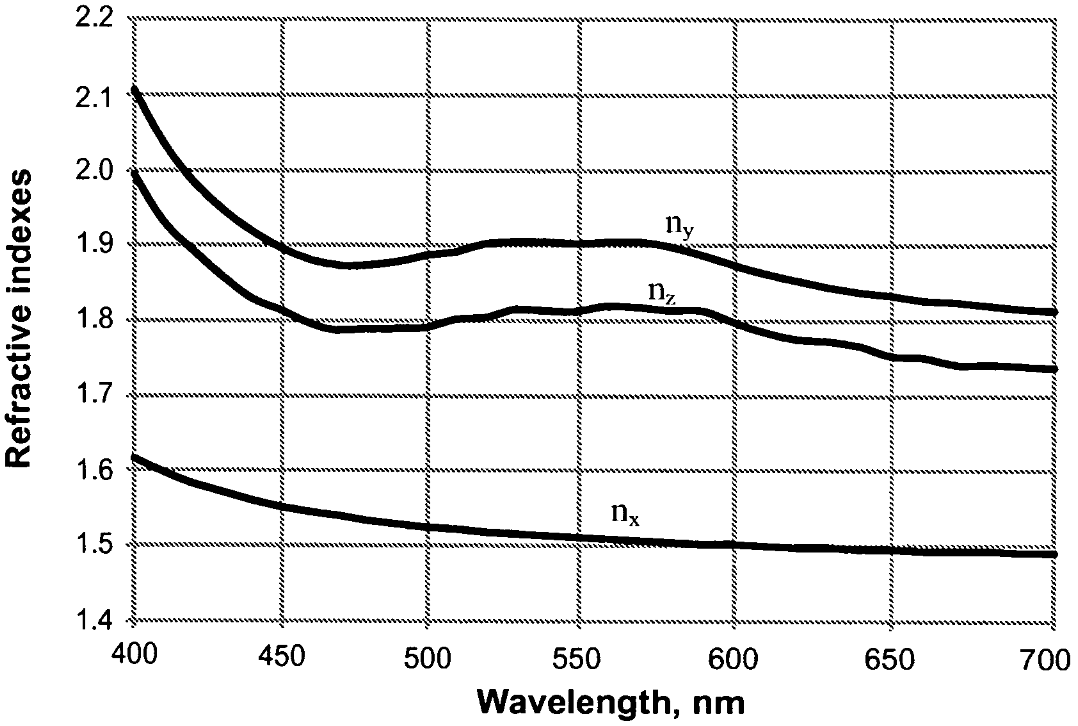

2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
Refractive indexes
400
450
500
550
600
650
700
Wavelength, nm
n_y
n_z
n_x

FIGURE 13

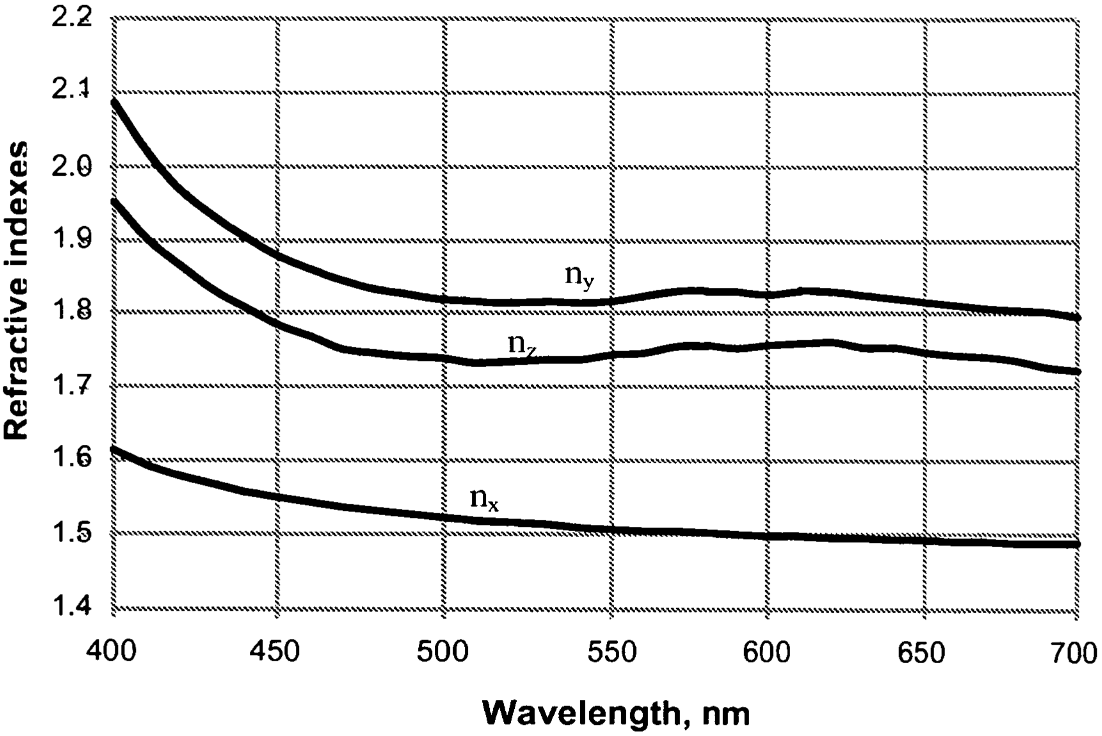

2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
Refractive indexes
400
450
500
550
600
650
700
Wavelength, nm
n_y
n_z
n_x

FIGURE 14

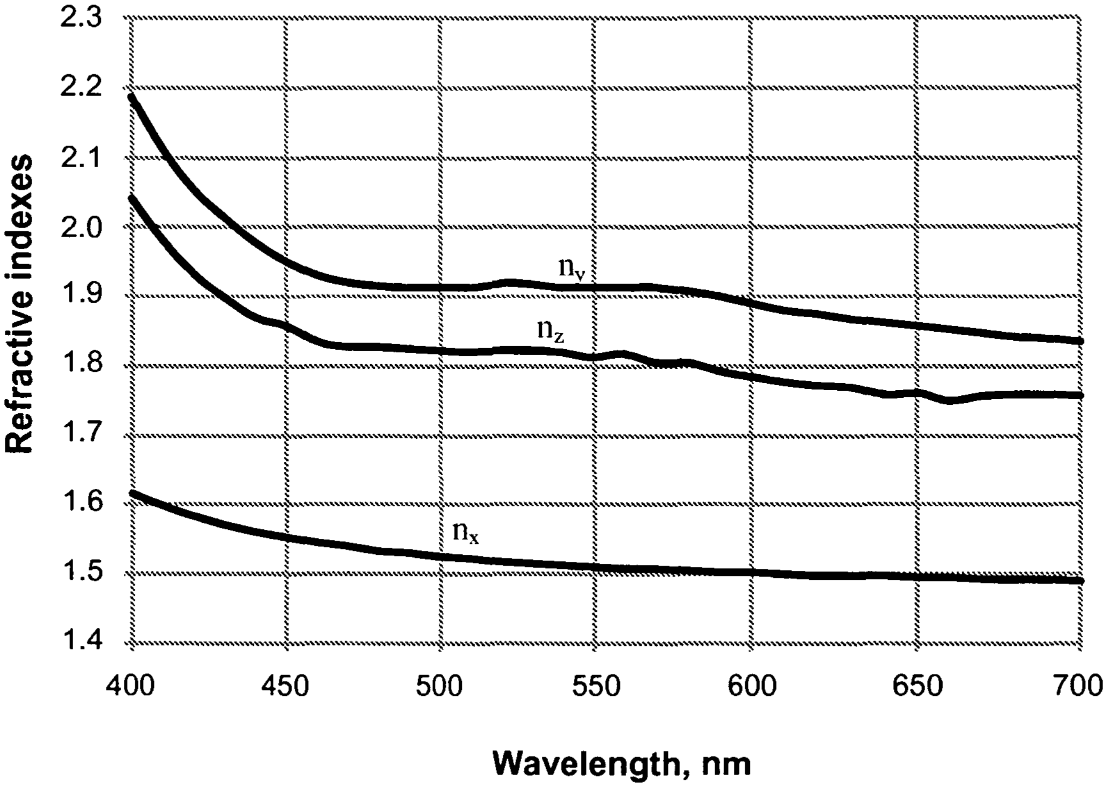

2.3
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
Refractive indexes
400
450
500
550
600
650
700
Wavelength, nm
n_y
n_z
n_x

FIGURE 15

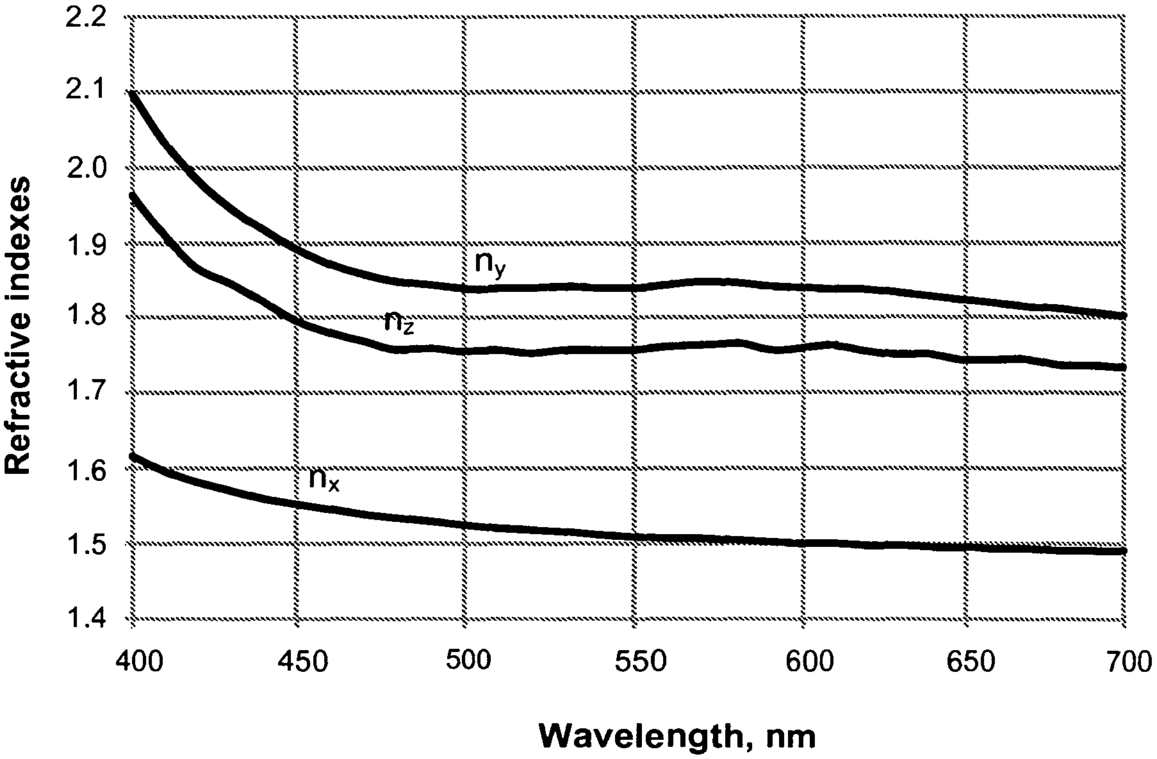

Refractive indexes
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
400
450
500
550
600
650
700
Wavelength, nm
n_y
n_z
n_x

FIGURE 16

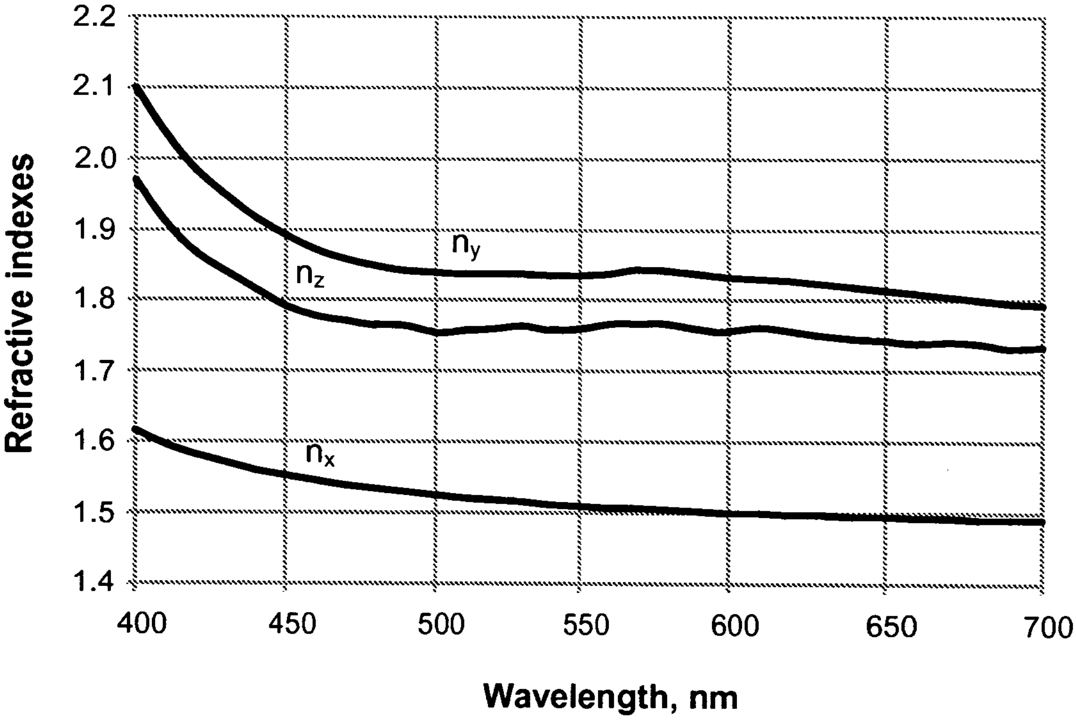

Refractive indexes
2.2
2.1
2.0
1.9
1.8
1.7
1.6
1.5
1.4
400
450
500
550
600
650
700
Wavelength, nm
n_y
n_z
n_x

FIGURE 17

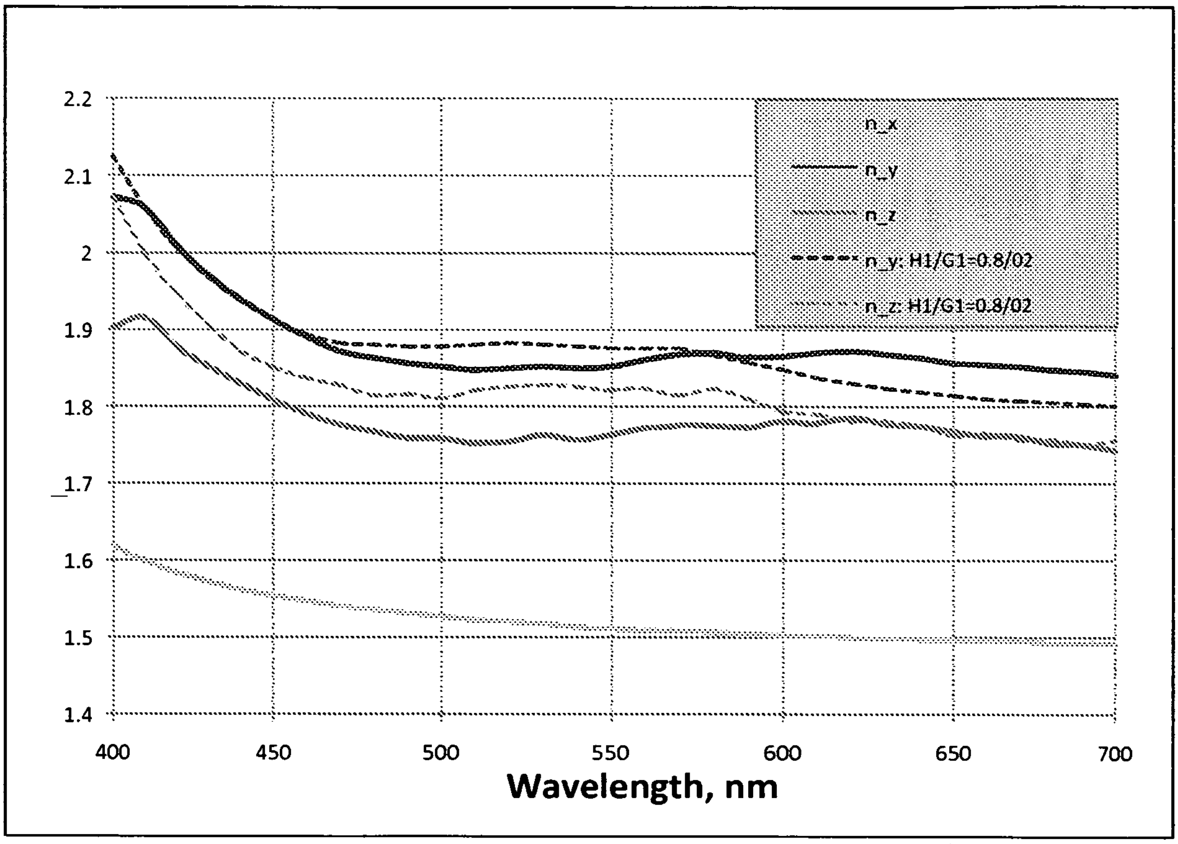

2.2
2.1
2
1.9
1.8
1.7
1.6
1.5
1.4
400
450
500
550
600
650
700
Wavelength, nm
n_x
n_y
n_z
n_y: H1/G1=0.8/02
n_z: H1/G1=0.8/02

FIGURE 18

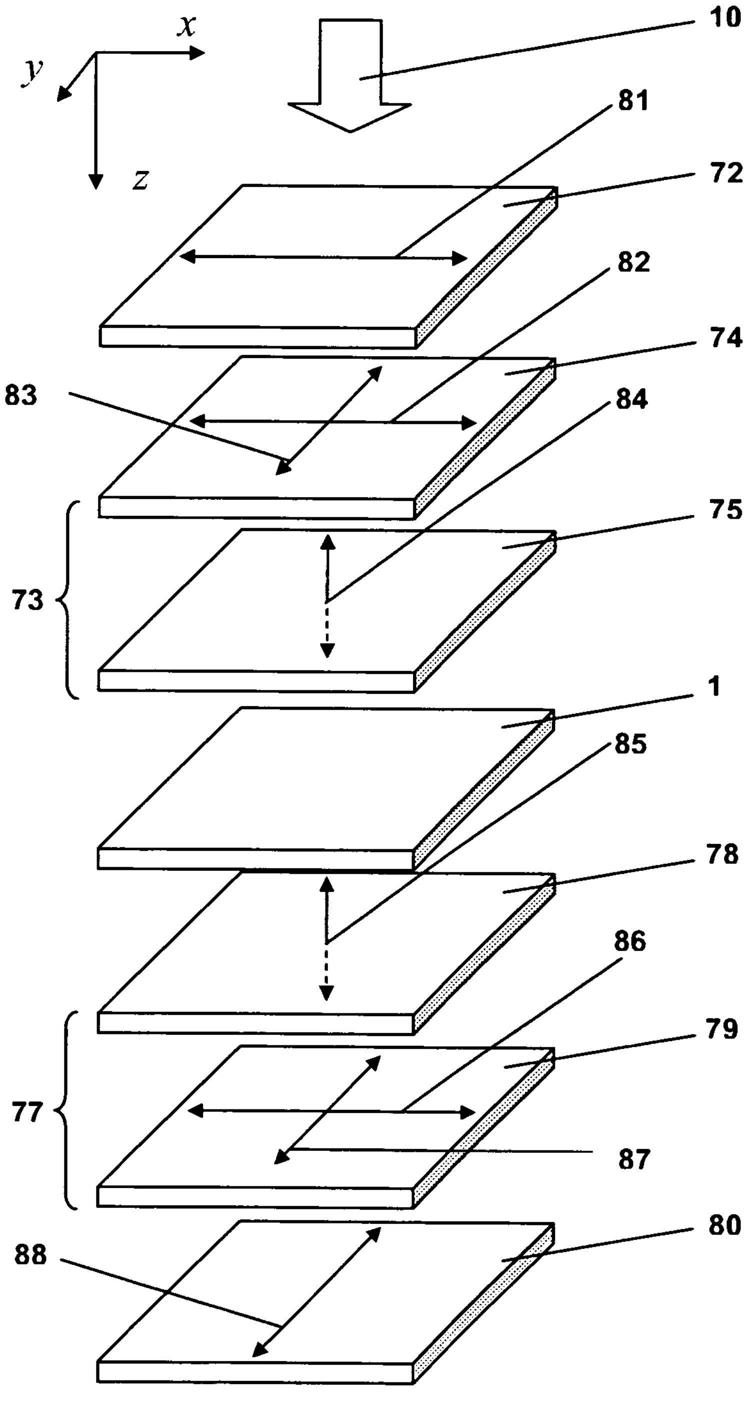


FIGURE 19

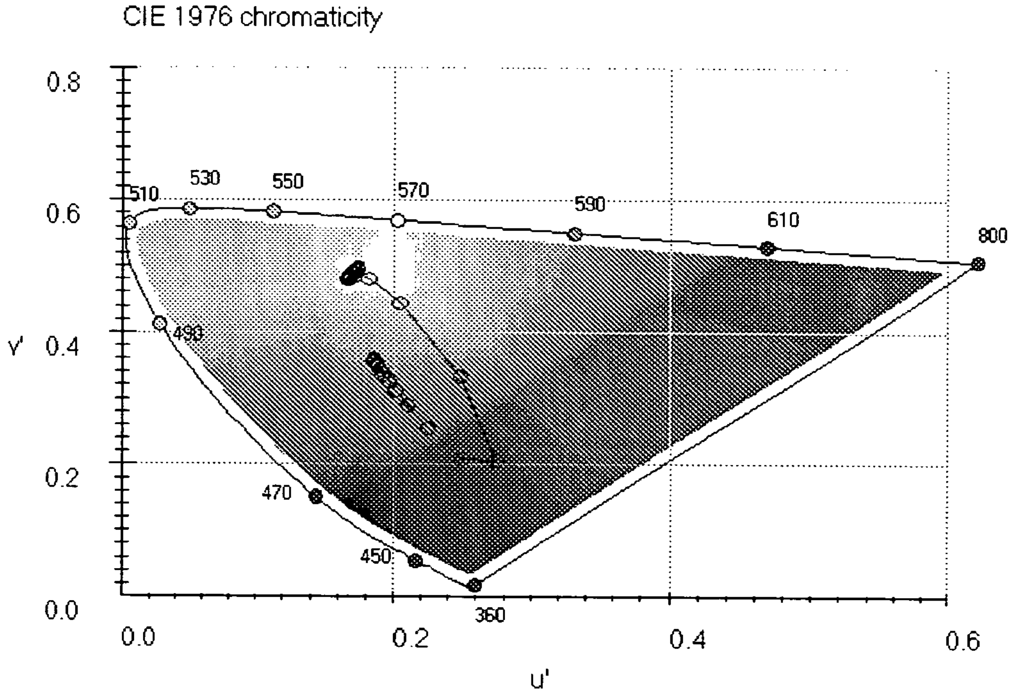

CIE 1976 chromaticity
0.8
0.6
0.4
0.2
0.0
v'
0.0
0.2
0.4
0.6
u'
510
530
550
570
590
610
800
490
470
450
360

FIGURE 20

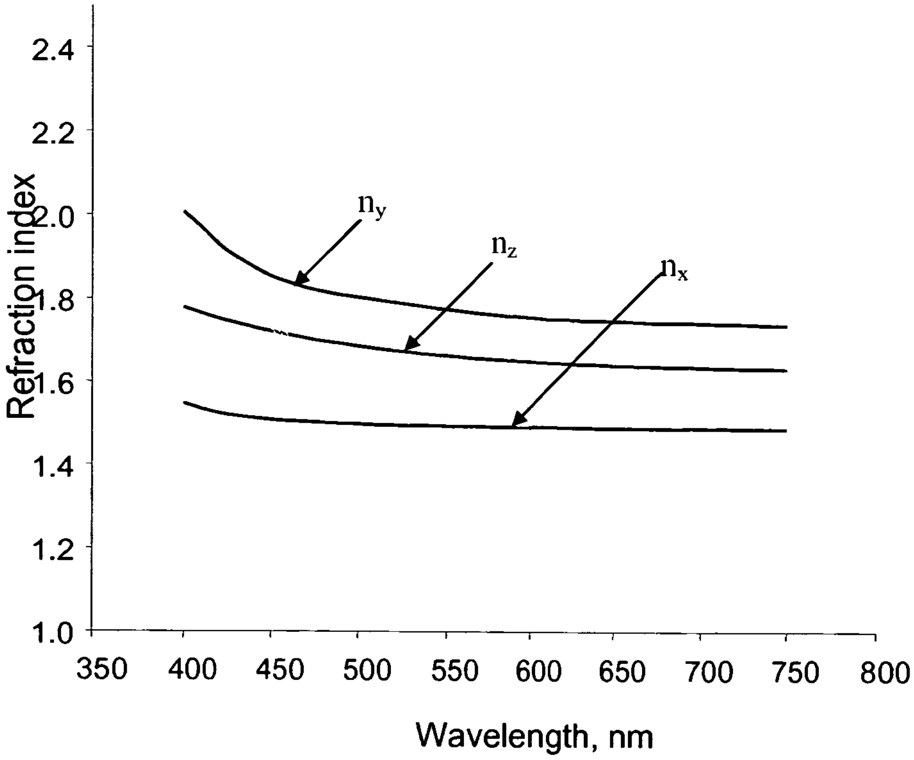

2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
Refraction index
350
400
450
500
550
600
650
700
750
800
Wavelength, nm
n_y
n_z
n_x

FIGURE 21

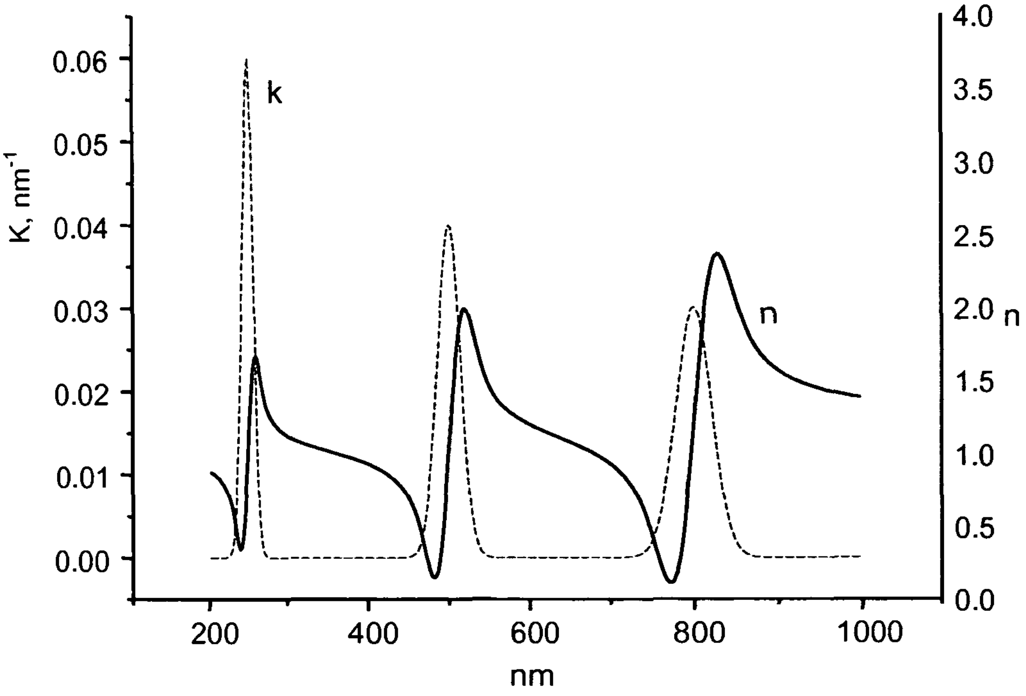

K, nm^{-1}
0.06
0.05
0.04
0.03
0.02
0.01
0.00
k
n
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
n
200
400
600
800
1000
nm

FIGURE 22

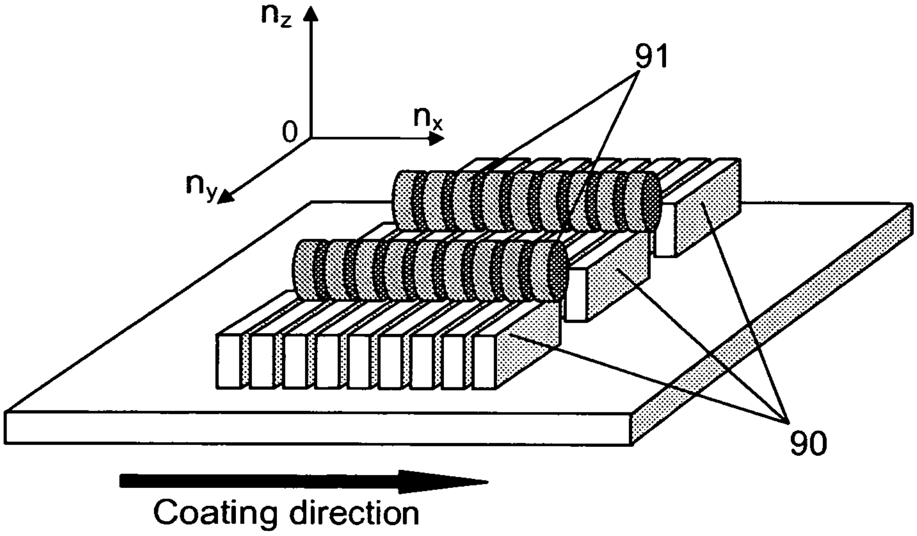


FIGURE 23

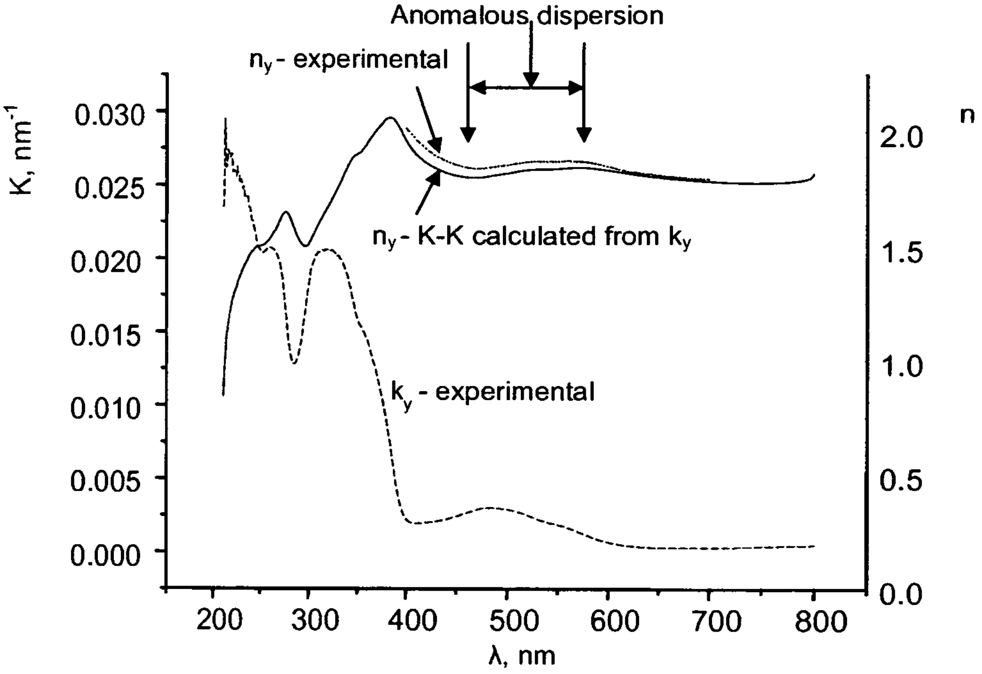

Anomalous dispersion
n_y - experimental
n_y - K-K calculated from k_y
k_y - experimental
K, nm^{-1}
0.030
0.025
0.020
0.015
0.010
0.005
0.000
200
300
400
500
600
700
800
λ, nm
n
2.0
1.5
1.0
0.5
0.0

FIGURE 24

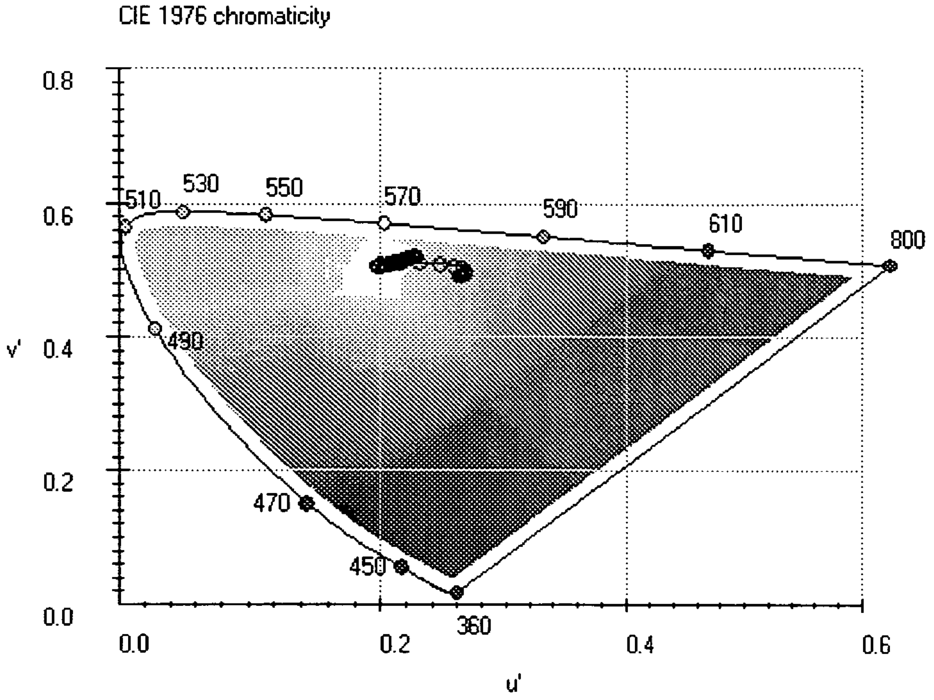

CIE 1976 chromaticity
0.8
0.6
v' 0.4
0.2
0.0
0.0
0.2
0.4
0.6
u'
510
530
550
570
590
610
800
490
470
450
360

FIGURE 25

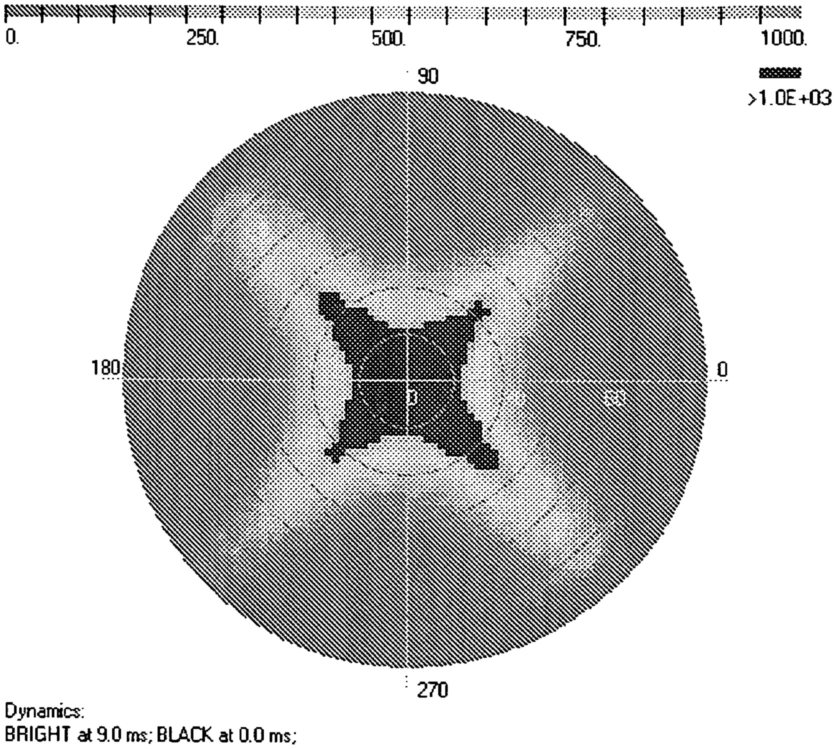

0.
250.
500.
750.
1000.
90
>1.0E+03
180
0
270
Dynamics:
BRIGHT at 9.0 ms; BLACK at 0.0 ms;

FIGURE 26a

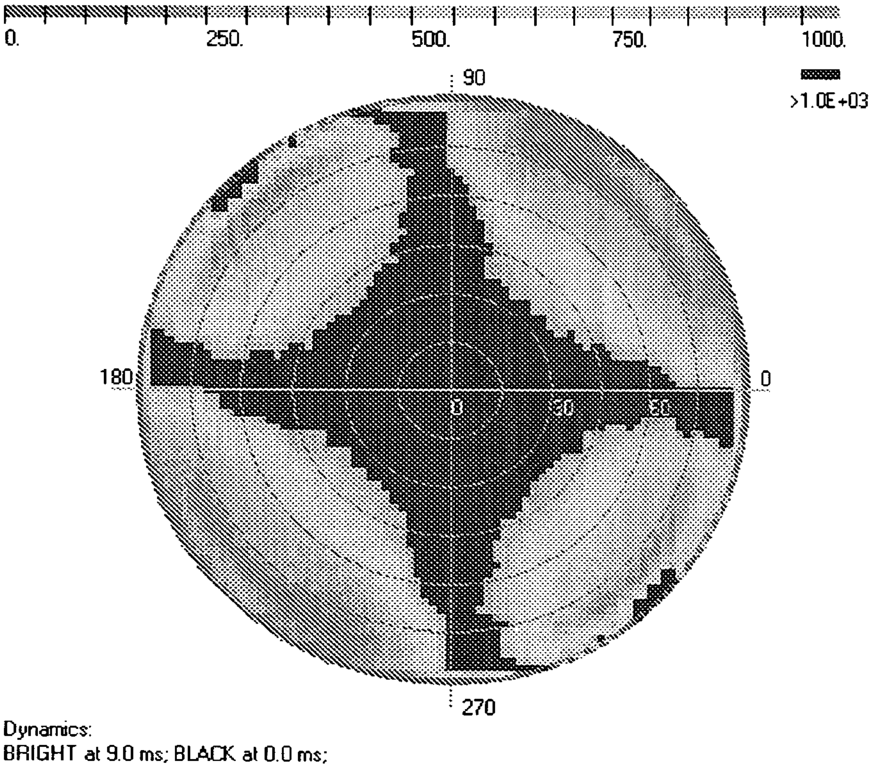

0.
250.
500.
750.
1000.
>1.0E+03
90
180
0
270
0
30
60
Dynamics:
BRIGHT at 9.0 ms; BLACK at 0.0 ms;

FIGURE 26b

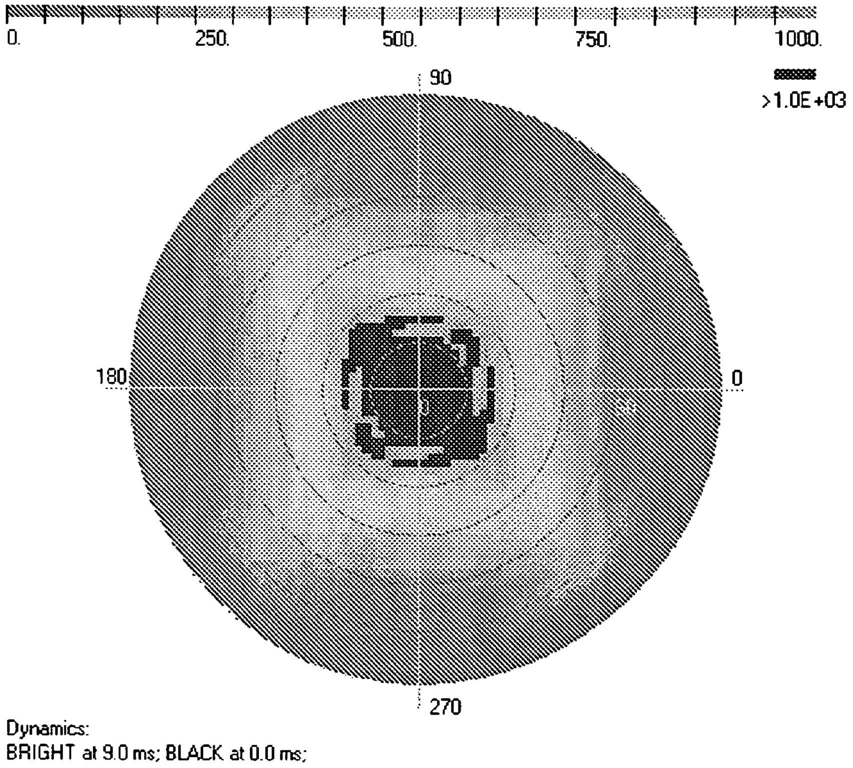

0.
250.
500.
750.
1000.
>1.0E+03
90
180
0
270
Dynamics:
BRIGHT at 9.0 ms; BLACK at 0.0 ms;

FIGURE 26c

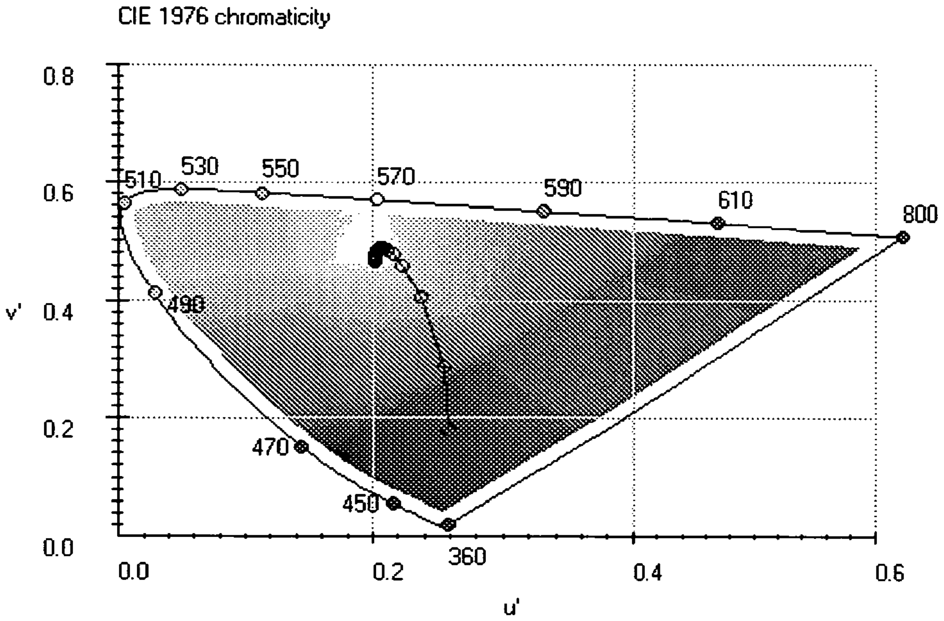

CIE 1976 chromaticity
0.8
0.6
0.4
0.2
0.0
v'
0.0
0.2
0.4
0.6
u'
510
530
550
570
590
610
800
490
470
450
360

FIGURE 27

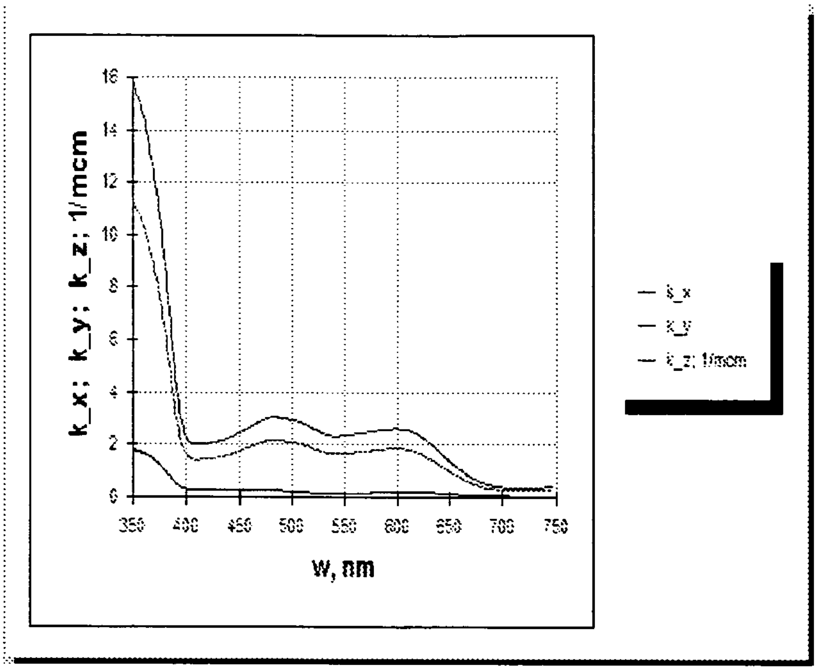

k_x; k_y; k_z; 1/mcm
16
14
12
10
8
6
4
2
0
350
400
450
500
550
600
650
700
750
w, nm
k_x
k_y
k_z; 1/mcm

FIGURE 28a

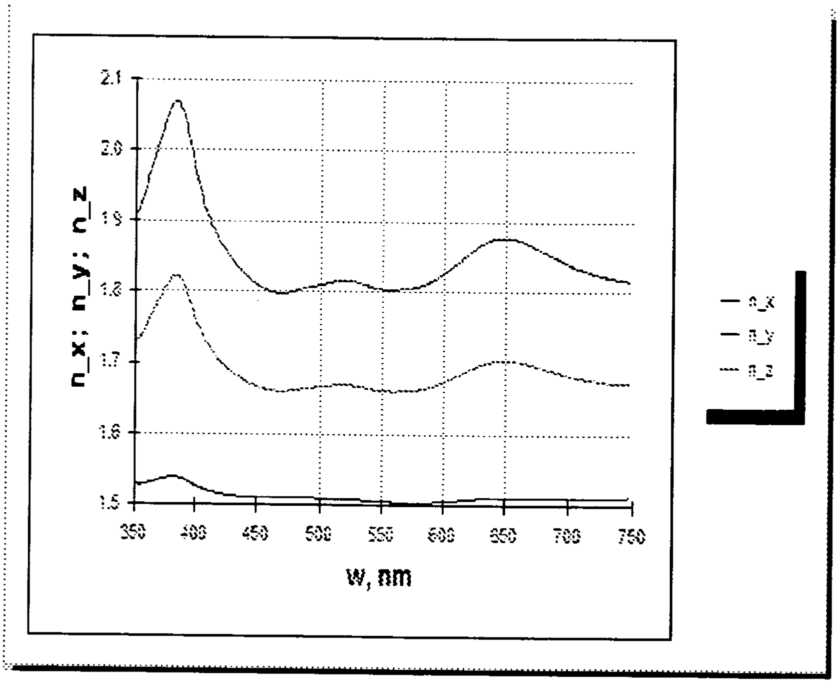

2.1
2.0
1.9
1.8
1.7
1.6
1.5
n_x; n_y; n_z
350
400
450
500
550
600
650
700
750
w, nm
n_x
n_y
n_z

FIGURE 28b

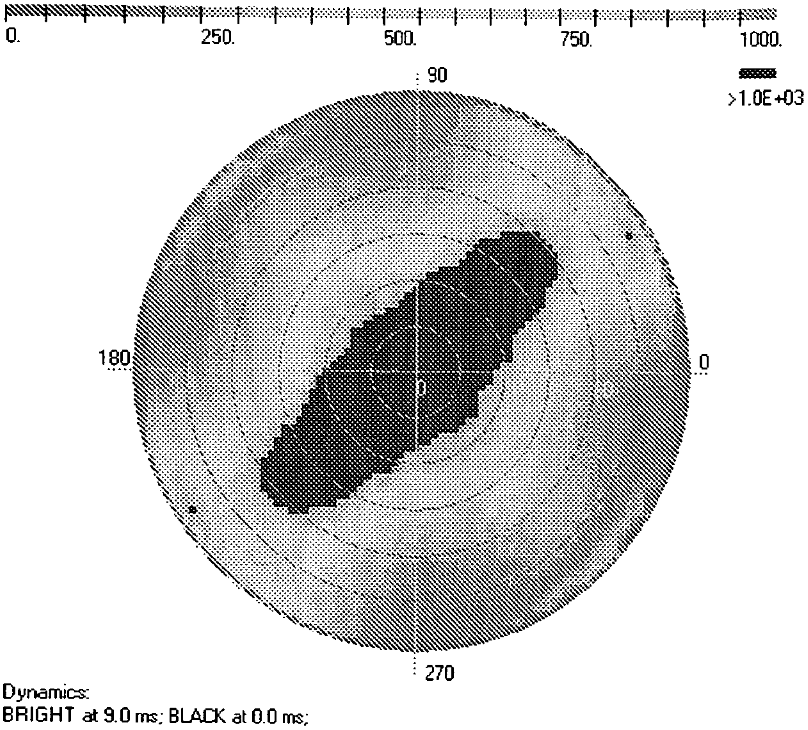

0.
250.
500.
750.
1000.
>1.0E+03
90
180
0
270
Dynamics:
BRIGHT at 9.0 ms; BLACK at 0.0 ms;

FIGURE 29a

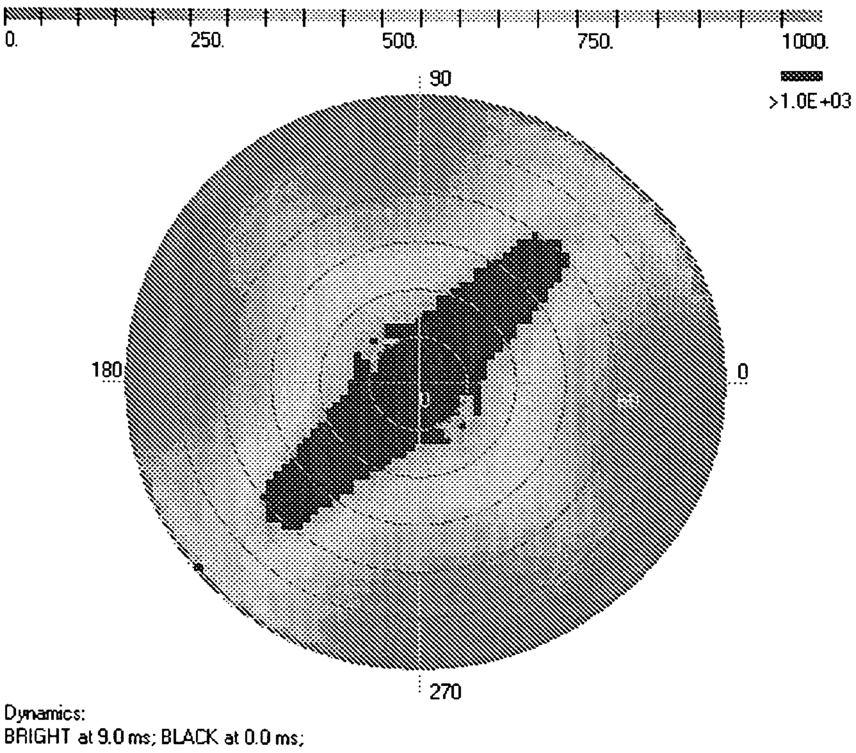

0.
250.
500.
750.
1000.
90
>1.0E+03
180
0
270
Dynamics:
BRIGHT at 9.0 ms; BLACK at 0.0 ms;

FIGURE 29b

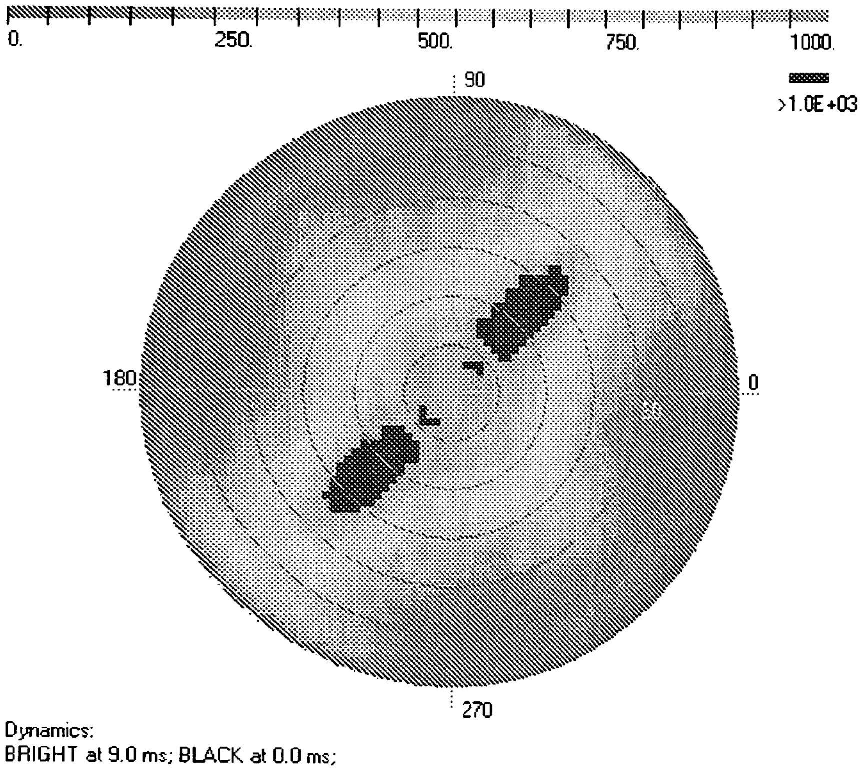

0.
250.
500.
750.
1000.
90
>1.0E+03
180
0
270
Dynamics:
BRIGHT at 9.0 ms; BLACK at 0.0 ms;

FIGURE 29c

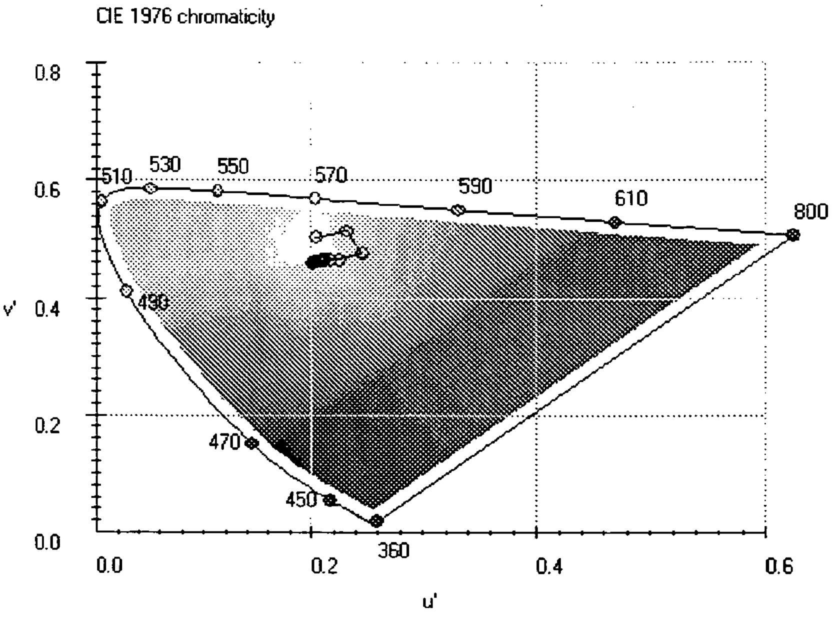

CIE 1976 chromaticity
0.8
0.6
v' 0.4
0.2
0.0
0.0
0.2
0.4
0.6
u'
510
530
550
570
590
610
800
490
470
450
360

FIGURE 30

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- WO 2007086599 A **[0018]**

专利名称(译)	彩色液晶显示和补偿面板		
公开(公告)号	EP2291703B1	公开(公告)日	2016-11-30
申请号	EP2009735427	申请日	2009-04-22
[标]申请(专利权)人(译)	CRYSOPTIX		
申请(专利权)人(译)	CRYSOPTIX株式会社		
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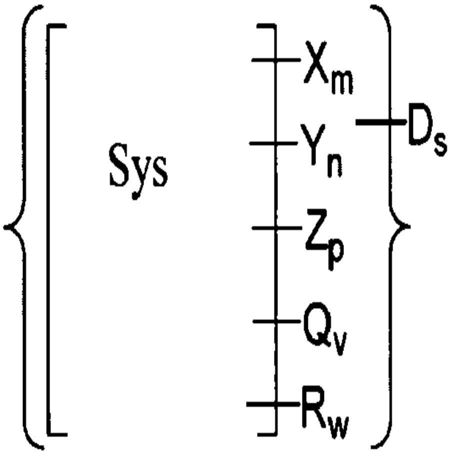
IPC分类号	G02F1/13363		
CPC分类号	G02F1/13363 G02B5/3008 G02B5/3083 G02F1/13725 G02F2001/133637 G02F2201/08 G02F2202/06 G02F2413/04 G02F2413/06 G02F2413/12 Y10T428/10 Y10T428/1059		
优先权	12/426329 2009-04-20 US 61/047876 2008-04-25 US		
其他公开文献	EP2291703A2		
外部链接	Espacenet		

摘要(译)

在本发明的一个方面，提供了一种光学各向异性补偿板，其具有光谱可控的折射率色散。补偿面板包括至少一个基于有序客体 - 主体系统的光学各向异性层。客体 - 主体系统包括各向异性主基质，其包括对可见光谱范围内的电磁辐射透明的有机化合物，和具有客体颗粒的客体组分。在另一方面，本发明提供了一种制备光学各向异性补偿面板的方法。并且在又一个实施例中，本发明提供了一种具有所公开的补偿面板的液晶显示器。



(I)