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# iMiD 2023

THE 23RD INTERNATIONAL  
MEETING ON INFORMATION  
DISPLAY | AUG 22-25

## About The Hong Kong University of Science and Technology

The Hong Kong University of Science and Technology (HKUST) (<https://hkust.edu.hk/>) is a world-class research intensive university that focuses on science, technology and business as well as humanities and social science. HKUST offers an international campus, and a holistic and interdisciplinary pedagogy to nurture well-rounded graduates with global vision, a strong entrepreneurial spirit and innovative thinking. Over 80% of our research work were rated "Internationally excellent" or "world leading" in the Research Assessment Exercise 2020 of Hong Kong's University Grants Committee. We were ranked 2nd in Times Higher Education's Young University Rankings 2023, and our graduates were ranked 30th worldwide and among the best from universities from Asia in Global Employability University Ranking and Survey 2022. As of early 2023, HKUST members have founded 1,645 active start-ups, including 9 Unicorns and 11 exits (IPO or M&A), generating economic impact worth over HK\$400billion. InvestHK cited QS World University Rankings by Subject 2021 to demonstrate the performance of five world's top 100 local universities in several innovation-centric areas, among which HKUST ranked top in four engineering and materials science subjects.

## Reverse Mode LC/ Polymer Smart Window

### TECHNOLOGY

The smart window is transparent when no voltage is applied. It scatters light efficiently upon the application of a suitable voltage. Such electrically switchable light controlling device can be applied to smart windows and transparent displays. The present device is based on a polymer - liquid crystal composite which is sandwiched in between conductive transparent substrates. Central to the invention is a special inhomogeneous alignment surfaces that can greatly enhance light scattering. Reverse mode operation with large viewing angle transparent voltage off state is achieved.

### APPLICATION

- Conference rooms
- Hotel rooms
- Vehicle windows
- Architectural windows and indoor privacy windows
- The global smart glass market is projected to grow from USD 5.0 billion in 2022 to USD 8.2 billion by 2027 with a CAGR of 10.4% from 2022 to 2027<sup>1</sup>

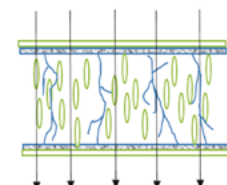
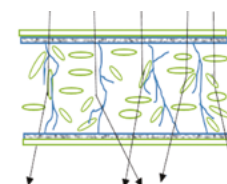
### ADVANTAGES

- Normally clear (reverse mode)
- Large viewing angle
- Low operating voltage
- Inhomogeneous surface layer enhancing the scattering effect during power on state



### INTELLECTUAL PROPERTIES

China Patent No. ZL201880033855.0



Reverse Mode: (off state)  
Transparent, (on state) Opaque

<sup>1</sup> "Smart Glass Market by Technology (Suspended Particle Display, Electrochromic Glass, Liquid Crystals, Micro blinds, NanoCrystals, Photochromic and Thermochromic), Application, Control Mode and Geographic Analysis - Global Forecast to 2027", published by MarketsandMarkets in May 2022

# High-Resolution Shadow Masks

## TECHNOLOGY

The high-resolution shadow masks provide a self-tensioned, ultra-flat silicon nitride mask (SNM) that enables the manufacture of a large area (>2"), ultrahigh-resolution (>2000 ppi) RGB side-by-side for OLED displays.

It also provides a method to produce large-scale SNM modules that comprise accurately aligned SNM masks (110) on a rigid carrier (130), enabling high-throughput patterning of multiple ultrahigh-resolution OLED panels on a single, large-area substrate.

## APPLICATION

- Applications in high-fidelity, high-resolution patterning of RGB side-by-side pixels in OLED displays for AR/VR
- Applicable for display manufacturing tools, AR/VR displays, and panel makers
- The AR/VR market size is projected to reach USD 31.12 billion in 2023 and is estimated to grow at around 14% CAGR between 2023 and 2027. (Statista, June 2023)

## ADVANTAGES

### A stitch-before-pattern method

- Produces SNM modules with accurately aligned hole arrays without the need for highprecision bonding
- Extends SNM to large scales with the capability of patterning multiple layouts on a large-area substrate
- Increases the mechanical strength of SNMs through the rigid carrier, i.e. glass or metal

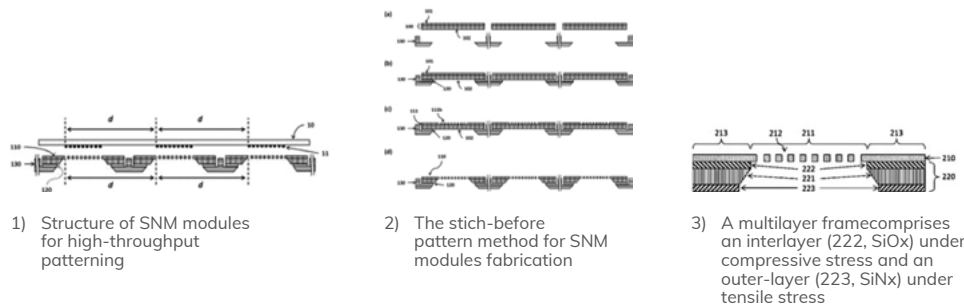
### Multilayer frame structure

- Reduces masks distortions, particularly unwanted curvatures in the mask frame, over extended dimensions. It balances the tensile stress of the SiNx membrane and improves the overall flatness of the NM
- Cost effective fabrication process at improved yields (>90%) while increasing the size of the SNM from <1 " to > 2"



## INTELLECTUAL PROPERTIES

US Patent No. 11638388



# Corrugated High-Resolution Shadow Masks

## TECHNOLOGY

A corrugated silicon nitride (SiNx) mask with elevated apertures for patterning high resolution OLED displays. This new structure is comprised of a corrugated, freestanding membrane (silicon nitride) which is suspended by a solid frame (Si). Apertures in the membrane are situated at the apexes of corrugations and elevated from the surrounding membrane. A fabrication process with greater than 90% yield has been achieved for the shadow masks.

## APPLICATION

- Applications in ultra high-resolution OLED displays, particularly for VR and smartphones
- Applicable for display manufacturing tools, AR/VR displays, and panel makers
- The AR/VR market size is projected to reach USD 31.12 billion in 2023 and is estimated to grow at around 14% CAGR between 2023 and 2027. (Statista, June 2023)

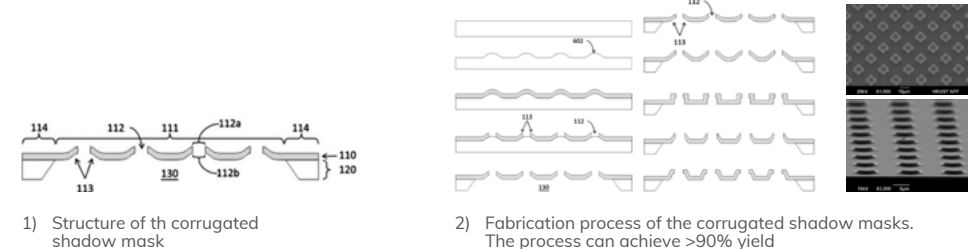
## ADVANTAGES

- The corrugated structure reduces the unwanted shadowing effect and improves the mask's mechanical integrity
- The SiNx masks reduces the current mask thickness in fine metal masks (FMM) from 10-20  $\mu\text{m}$  to 1  $\mu\text{m}$  or less and improves its aperture density from <1000 ppi to up to 6000ppi
- A corrugated SiNx mask can increase the resolution and active pixel area of OLED displays by bringing the mask aperture closer to the device substrate without changing the gap
- The apertures on the mask is projected by the corrugation so that the aperture is closer to the substrate even in the presence of a gap
- This structure provides directional strengthening of the mask membrane while the peripheral corrugations improves the mask's mechanical strength



## INTELLECTUAL PROPERTIES

International Patent Filing No. PCT/CN2022/119552



# Materials and Methods of Making Photo-aligned Vertical Alignment Layer for LCDs

## TECHNOLOGY

A Vertical alignment (VA) mode is widely adopted for various types of displays due to its high on axis contrast ratio, wide viewing angle and fast response time when compared with other liquid crystal modes such as twisted nematic (TN) or in-plane switching (IPS).

The present invention is related to the materials and methods for preparing a vertical alignment layer with preferred azimuthal angle. It is a single layer single exposure process in which vertical polyimide alignment material and photo-aligned material are included.

## APPLICATION

- Vertical Alignment LCD
- Multi-domain capability
- Global Liquid Crystal Display (LCD) Market valued at USD 148.60 billion in 2021 and expected to reach USD 1422.83 billion by 2029, registering a CAGR of 32.63% growth<sup>1</sup>

## ADVANTAGES

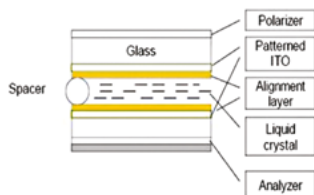
- Non-contact Method
- Clean Process
- Higher production yield
- Easy scale-up
- Multi-domain feasible (for all viewing angle LCD)
- Photo reactive material used



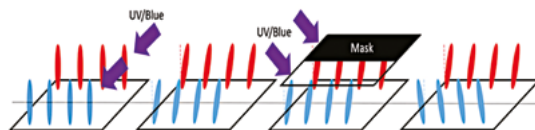
## INTELLECTUAL PROPERTIES

US Patent No. US20190331625A1  
China Patent No. 201910362014.0

US Patent No. 16/947238



1) Diagram of Alignment Layer



2) Illustration showing the potential multi-domain application of our optically re-writable material

<sup>1</sup> DATA BRIDGE Market Research, "Global Liquid Crystal Display (LCD) Market – Industry Trends and Forecast to 2029" May 2022

# Organic Down-Conversion Films for Display

## TECHNOLOGY

An organic down-conversion film comprising of a host-dopant composition for changing the wavelength of emission from a blue light-emitting device (LED). The host material comprises a class of organic compounds with one or more perylene moieties in their molecular structures for absorbing the blue light emitted from the LED. In turn, it acts as an energy donor for sensitizing the dopant material, which, as an energy acceptor, comprises various luminescent molecules capable of producing light of a longer wavelength than blue. The preferred host materials are perylene-based molecules containing various steric substitutions within the perylene moieties or in the other parts of the molecular structure to prevent aggregation among the host molecules and between the host and dopant molecules.

## APPLICATION

- Applications in high-fidelity, high-resolution patterning of RGB side-by-side pixels in OLED displays for AR/VR
- Applicable for display manufacturing tools, AR/VR displays, and panel makers
- The AR/VR market size is projected to exceeded USD 31.12 billion in 2023 and is estimated to grow at around 14% CAGR between 2023-2027. (Statista, June 2023)

## ADVANTAGES

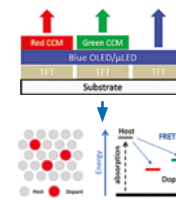
- More efficient solution to convert blue light to a light of lower power through photon down-conversion
- Using a patterned perylene based-film results in:
  - Thin film (<1 μm)
  - High resolution/low refraction (>2000 ppi) through film
  - High absorption coefficient in blue
- Evaporable host and dopant leads to great potential for large scale manufacture



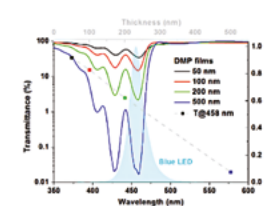
## INTELLECTUAL PROPERTIES

China Patent No. 202111036825.5

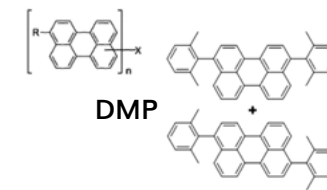
Hong Kong Patent No. 302477205



1) Host-dopant structure. It presents concentration quenching without diluting absorption



2) Transmittance of DMP films of different thicknesses and the emission of a 455-nm blue LED. Blue absorption of greater than 99% is achieved at 500nm



3) Molecular structure of DMP (bis(2,6-dimethylphenyl) perylene) – a perylene derivative. R is a steric group and X is a steric group or bridging group



# Ferroelectric Liquid Crystals Dammann Grating for Light Detection and Ranging Devices

## TECHNOLOGY

A ferroelectric liquid crystal Dammann grating (FLCDG) based polarization modulated depth-mapping system. Innovatively, we used the ferroelectric liquid crystal Dammann grating as high-speed shutter in this system. The raster scanning system is replaced with a one-time projection for the whole target. Apart from that, a charge-coupled device (CCD) camera and an electro-optical modulator are included as imaging sensor and modulator for time-resolution, respectively. The application of ferroelectric liquid crystal Dammann grating enables Light Detection and Ranging as one-shot capturing system instead of iterative scanning. Thus, the proposed method is a promising option for Light Detection, Ranging, and 3D imaging.

## APPLICATION

- Applications include Liquid Crystal Displays (LCD), Lidars, 3D-mapping
- OLED market size is exceeded USD 37 billion in 2021 and is estimated to grow at around 21% CAGR between 2022 and 2030. (Precedence Research, Sept. 2022)

## ADVANTAGES

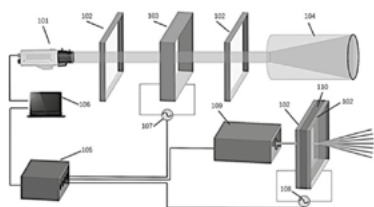
- The data collection procedure is sped up by replacing the raster scanning system with one-time projection for whole target
- Low costs of light detection and ranging with fast switching FLC
- No moving parts
- High uniformity of projected light beams



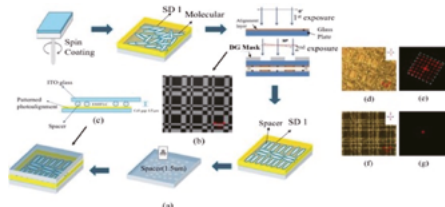
## INTELLECTUAL PROPERTIES

US Patent No. 17/004530

China Patent No. 202010891983.8



- 1) Exemplary schematic diagram of ferroelectric Liquid crystals Dammann grating for Light Detection and Ranging Devices, where the receiver includes one detector



- 2) (a) Fabrication of FLCDG  
(b) Micro-graph of DF mask  
(c) The cell structure of the FLCDG  
(d) POM (polarizer optical diagram) of diffractive state  
(e) Diffractive pattern of diffractive state  
(f) POM of non-diffractive state  
(g) Diffractive pattern of non-diffractive state

# Ferroelectric Liquid Crystal Materials

## TECHNOLOGY

Ferroelectric liquid crystal (FLC) materials show an advanced performance for electrooptical devices by exploiting the deformed helix ferroelectric liquid crystal effect. The majority of the constituent material is three or four ring molecules of chiral and nonchiral components, which provides birefringence value in the range of 0.14 to 0.28, and ferroelectric phase temperature ranges are broader than 0 to 90 °C. The spontaneous polarization value of the FLC is in the range of 50 to 200 nC/cm<sup>2</sup>, which is achieved by adding highly polar groups (F, CF<sub>3</sub>, O, etc.) at the chiral centers of the chiral components. The tilt angle of 35° to 46° for the FLC material is provided by matching the total length of the host with the chiral components molecules and by minimal differences of the terminal tail length on both sides of the central core of the molecules. The FLC helix pitch of 250 nm or less was provided by doping the high-twisting power chiral components in the host.

## APPLICATION

- Applications such as various different types of displays, and is important for the emerging industry of AR/VR displays
- The displays market reached USD 115 billion in 2021 and is estimated to grow at around 7% CAGR between 2022-2031. (Allied Markets Research, Jan. 2023)

## ADVANTAGES

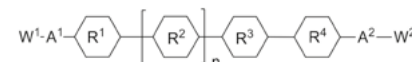
- High birefringence ranging between 0.16-0.30 Dn
- Fast analogue EO modulation
- Faster response times by using FLCs of 10 μs at driving voltage 4V/μm and 120 μs at driving voltage 1V/μm
- Helix pitch is much smaller than the cell gap and below visible range at <250nm provided by high polarization power
- Working range of 0 - 90 °C



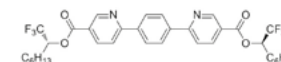
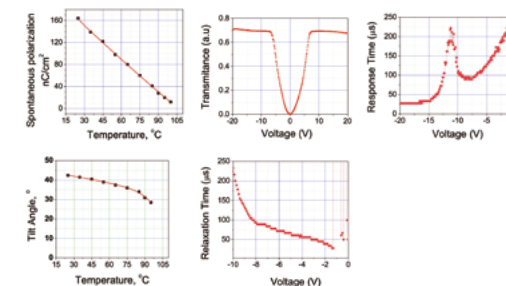
## INTELLECTUAL PROPERTIES

US Patent No. 18/165361

China Patent No. 202310074886.3



- 1) FLC material for the deformed helix FLC electro-optical mode devices comprises of at least 2 components and shows optimum electro-optical properties, wherein at least one FLC component is a chiral compound as shown above



- 2) Selection of the electrooptical properties of the FLC material. It is the mixture of 25 mol.% chiral component: in BPP-4 host.

# > Field Sequential Color Ferroelectric Liquid Crystal Display Cell

## TECHNOLOGY

A field sequential color display based on electrically suppressed helix ferroelectric liquid crystal display cell, which is comprised of a ferroelectric liquid crystal display cell, light emitting diodes to illuminate pixels, sequentially in time wherein the Ferroelectric liquid crystal display cell with fast response comprising a ferroelectric liquid crystal whose helix pitch is less than thickness of liquid crystal layer and the elastic energy of the helix is compulsorily higher than the effective anchoring energy. The frame rate of 240Hz has been demonstrated for the field sequential color display based on electrically suppressed helix ferroelectric liquid crystal by changing the residual light of the cell to generate 8 bit gray levels in each sub frame thus total 24bit colors have been achieved.

## APPLICATION

- Applications for LCD displays and LCOS projector manufacturing
- The LCD market reached USD 148 billion in 2021 and is estimated to grow at around 32% CAGR between 2022-2029. (Data Market Research, May 2022)

## ADVANTAGES

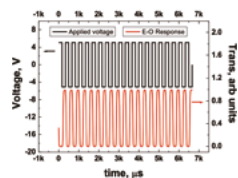
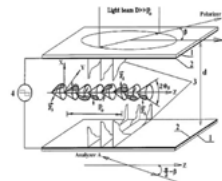
- Exhibits fast response, wide viewing angle, high contrast ratio of 10000:1 and color triangle more than 130% of NTSC at the electric field less than 3.5 volts/ $\mu\text{m}$
- The electrically suppressed helix ferroelectric liquid crystal display shows very high optical contrast, fast electro-optical response less than 10 $\mu\text{s}$ , and saturated electro-optical modulation up to the frequency of 5 kHz at the electric field of 5V/ $\mu\text{m}$
- Low power consumption



## INTELLECTUAL PROPERTIES

US Patent No. US9366934

- 1) Helical structure of chiral smectic C\* phase layer whose thickness  $d$  is bigger than the helix pitch  $p_0$ : 1 – substrates, transparent for the visible light, 2 – conductive layers, transparent for the visible light and covered with any aligning layer, 3 – smectic layers, which are perpendicular to the substrates, 4 – a source of driving voltage, is an angle between polarizer plane and the helix axes at the absence of the applied voltage, D – light beam aperture, which is considerably bigger than the helix pitch



- 2) The Electro-optical response of the ESHFLC Display cell, top is the applied voltage and in bottom represents electro-optical response of the ESHFLC display cell at temperature  $(T) = 22^\circ\text{C}$ , wavelength  $(\lambda) = 0.63 \mu\text{m}$  and the operational frequency  $(f)$  of 3 kHz



- 3) Some of the achieved colors with different gray levels

# > Electrically Suppressed Helix Ferroelectric Liquid Crystal Display Cell

## TECHNOLOGY

A display cell based on electrically suppressed helix ferroelectric liquid crystal display cell, which comprise of a ferroelectric liquid crystal display cell, light emitting diodes to illuminate pixels, wherein the Ferroelectric liquid crystal display cell with fast response comprising a ferroelectric liquid crystal whose helix pitch is less than thickness of liquid crystal layer and the elastic energy of the helix is compulsorily higher than the effective anchoring energy. The frame rate of 240Hz has been demonstrated for the display based on electrically suppressed helix ferroelectric liquid crystal by changing the residual light of the cell to generate 8 bit gray levels by mean of pulse width modulation have been achieved.

## APPLICATION

- Applications for LCD displays and LCOS projector manufacturing
- Huge potential to find application in high-resolution display systems and replace existing alternatives including IPS, FFS and AFS system
- The LCD market reached USD 148 billion in 2021 and is estimated to grow at around 32% CAGR between 2022-2029. (Data Market Research, May 2022)

## ADVANTAGES

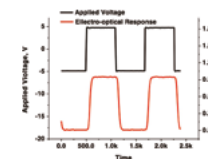
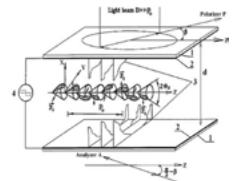
- Exhibits fast response, wide viewing angle, high contrast ratio of 10000:1 at the electric field less than 3.5 volts/ $\mu\text{m}$
- The electrically suppressed helix ferroelectric liquid crystal display shows very high optical contrast, fast electro-optical response less than 10 $\mu\text{s}$ , and saturated electro-optical modulation up to the frequency of 5 kHz at the electric field of 5V/ $\mu\text{m}$
- Low power consumption



## INTELLECTUAL PROPERTIES

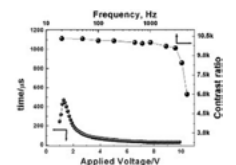
US Patent No. US9946133

- 1) Helical structure of chiral smectic C\* phase layer whose thickness  $d$  is bigger than the helix pitch  $p_0$ : 1 – substrates, transparent for the visible light, 2 – conductive layers, transparent for the visible light and covered with any aligning layer, 3 – smectic layers, which are perpendicular to the substrates, 4 – a source of driving voltage, is an angle between polarizer plane and the helix axes at the absence of the applied voltage, D – light beam aperture, which is considerably bigger than the helix pitch



- 2) The Electro-optical response of the ESHFLC Display cell, top is the applied voltage and in bottom represents electro-optical response of the ESHFLC display cell at temperature  $(T) = 22^\circ\text{C}$ , wavelength  $(\lambda) = 0.63 \mu\text{m}$  and the operational frequency  $(f)$  of 1 kHz

- 3) The electro-optical characteristics of the ESHFLC display cell. The bottom solid circles represent the response time against the driving voltages. The solid circles on the top show optical contrast against the applied frame frequency at the driving voltage of 2V/ $\mu\text{m}$



# > An Exposure System for Photo-Alignment

## TECHNOLOGY

An exposure system suitable for the photo-alignment of LCD. The present invention uses LEDs as an exposure light source instead of a mercury lamp. Since each LED chip is very small, only a micro-optical lens is required to perform light collimation. An LED array with a suitable collimation lens can produce a uniform parallel exposure area. Our innovation is that we have invented a new LED lamp installation method. The LED is not mounted on the same horizontal plane, but is installed in a row-by-row tilt so that all points on the substrate or exposure area has the same distance from the emitting source, which guarantees uniform illumination intensity. In addition, the adjustable LED emission angle and the exposure head azimuthal angle are also features of the present invention. The complete photo-alignment exposure system also includes cooling and control systems.

## APPLICATION

- For Liquid Crystal Displays manufacturing where oblique light exposure is necessary, such as photo-alignment of VA mode LCD
- The LCD market reached USD 148 billion in 2021 and is estimated to grow at around 32% CAGR between 2022-2029. (Data Market Research, May 2022)

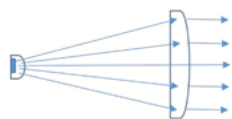
## ADVANTAGES

- Increased cost efficiencies
- Less bulky relative to the present use of mercury lamps
- Improved manufacturing ease

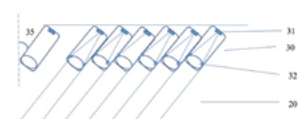


## INTELLECTUAL PROPERTIES

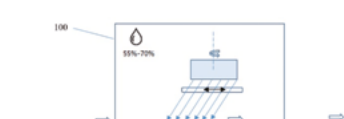
China Patent No. ZL201821117303.1



1) The LED collimation design



2) Equidistant oblique illumination surface light source LED installation method. 30 is the LED module; 31 is the chip; 32 is the collimating lens group; 35 is the inclination angle of the LED module



3) The complete exposure system plus housing, including humidity control. 100 is the system shell

# > Fast Switchable and High Diffraction Efficiency Grating Ferroelectric Liquid Crystal Cell

## TECHNOLOGY

This Invention discloses ferroelectric liquid crystal grating cell comprising of a chiral smectic liquid crystal whose helix pitch is less than thickness of liquid crystal layer placed between two polarizers and ac rectangular voltage has been applied to the electrodes of the cell, whose amplitude is higher than critical voltage amplitude of the helix unwinding.

The cell has two alignment domains forming grating structure, wherein the helical axes in the adjacent alignment domain are deployed at an angle  $90^\circ$  with respect to each other and parallel to the surface of the cell, by means of photo alignment. The different alignment in the adjacent alignment domains has been achieved by two-step photo exposure of an optically active sulfonic Azo dye SD1 layer, coated on the transparent conducting glass plate.

## APPLICATION

- Applications for LCD displays, LCOS projector, and pico projectors
- The LCD market reached USD 148 billion in 2021 and is estimated to grow at around 32% CAGR between 2022-2029. (Data Market Research, May 2022)

## ADVANTAGES

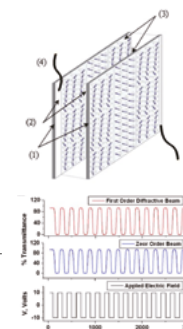
- Shock stability
- Low power consumption
- No unwanted diffraction lobes
- Fast response time
- Good alignment characteristics
- High contrast ratio 7000:1
- The gratings, in the cooperation with the electrically suppressed helix electro-optical mode, show very high optical contrast, small electro-optical response, less than  $10\mu s$ , and perfect electro-optical modulation up to frequency of 5 kHz at the electric field of  $7V/\mu m$



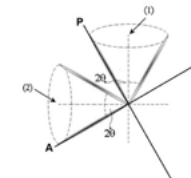
## INTELLECTUAL PROPERTIES

US Patent No. US9575366

- 1) Ferroelectric liquid crystal grating cell having two alignment domains wherein alignment direction are mutually perpendicular to each other and smectic layers are perpendicular to the substrate: 1 – substrates, transparent for the visible light, 2 – conductive layers, transparent for the visible light and covered with any aligning layer, 3 – smectic layers, which are perpendicular to the substrates, 4 – wire for electrical connection



- 2) Schematic diagram of the ferroelectric liquid crystals in two different alignment domain between two crossed polarizers, where P is polarizer, A is analyzer



- 3) The Electro-optical response of the FLC grating cell, bottom is the applied voltage, middle – electro-optical response of the zero order beam and in top represents electro-optical response of first order diffracted beam at temperature  $(T)=22^\circ C$ , wavelength  $(\lambda)=0.63 \mu m$  and the operational frequency  $(f)$  of 5 kHz

# Method for Preparation of Stable and Bright Luminescent Quantum Rod Nanocomposite

## TECHNOLOGY

Implementation of Quantum Dots embedded with LED instead of backlight LED could reduce the cost and eliminate additional films like the case of quantum dots. Also, thermal quenching of quantum dots reduces the efficiency because of high temperature on top of LED chip.

Synthesis method of quantum rod down-converting nanocomposite wherein, CdSe/CdS dot-in-rod material capable to undergo the cation exchange reaction by Cd<sup>2+</sup> to Zn<sup>2+</sup> exchange reaction, depending on the surface defects configuration can also proceed with a serious increase of the emission FWHM (full width at half maximum of the luminescence peak) and takes many hours at temperature ~350 °C to achieve green (lem ~ 520 nm) emitting product.

## APPLICATION

- Display market
- Lighting market
- The Quantum Dot Market Size is expected to reach USD 8.6 billion by 2026 from USD 4.0 billion in 2021, at a CAGR of 16.2% during the forecast period<sup>1</sup>
- The LED Lighting Market size is estimated at USD 100.20 billion in 2023, and is expected to reach USD 171.53 billion by 2028, growing at a CAGR of 11.35% during the forecast period (2023-2028)<sup>2</sup>

## ADVANTAGES

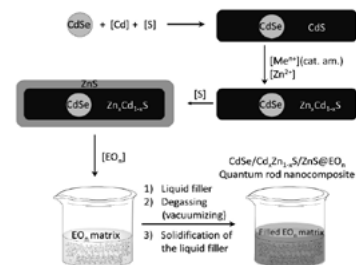
- Reduction of huge material consumption, production cost and light losses as compared with Quantum dot
- Higher display efficiency and brightness as compared with Quantum dot display
- Improving photo stability and luminescence properties



## INTELLECTUAL PROPERTIES

US Patent No. US10948774  
China Patent No. ZL201780029237.4

US Provisional Patent No. 63/425283



Block diagram of preparation of quantum rod nanocomposite

<sup>1</sup> April 12, 2023, Source: MarketsandMarkets Research Pvt. Ltd.  
<sup>2</sup> Mordor Intelligence

# A Dynamic E-Book and Its Reading Device

## TECHNOLOGY

An electronic book with static and dynamic content, and the content includes text, picture, animation and video. Different content categories can be played at different refresh rates. Static content such as text and pictures can use a lower refresh rate, animations can use a medium refresh rate, and videos can be played at the highest refresh rate. E-book readers that change the screen refresh rate according to the displayed content can save more power and have better refresh capabilities.

## APPLICATION

- Applications include various digital reading displays such as E-books or tablets
- The E-book market is projected to exceed USD 14 billion in 2023 and is estimated to grow at around 2% CAGR between 2023-2027. (Statista, July 2023)

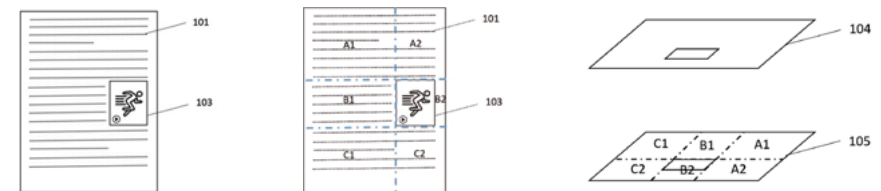
## ADVANTAGES

- E-book with video mode feature for dynamic information
- Text mode low frequency driving for power saving



## INTELLECTUAL PROPERTIES

China Patent No. 202210578775.1



- 1) Shows that the electronic book in the embodiment of the present invention contains dynamic content (103)
- 2) Shows that the electronic book in the embodiment of the present invention contains dynamic content (103)
- 3) Shows the hierarchical structure of the content of the electronic book in the embodiment of the present invention

Display Modes	Static	Dynamic	
	Image/Text	Animation	Videos
Refresh Rates	≤10Hz	20-40Hz	≥60Hz

- 4) A list of the different refresh rates for different display modes of the e-book reader