The Development of New Reflective LCDs with High Performance

Danghui Li

R&D Center, IRICO group company, Xianyang, Shannxi Province, PRC

Phone : +86-0910-3332511, e-mail : ldh@ch.com.cn

Abstract

Various technologies for new reflective LCDs with high performance are reviewed in this paper. Among of them, reflective STN-LCDs with single polarizor, novel single polarizor reflective LCDs based upon R-IPS mode and VA(vertical aligned) mode reflective color TFT-LCDs are discussed comprehensively. In addition, some new technologies which are under developed for the moment are also introduced briefly, including single polorizor reflective AF-LCDs (Antiferroelectric LCD) and reflective LCDS with none polorizor. Finally, we research the method to optimize the reflective LCDs.

Keywords

reflective LCDs, single polarizor, reflectivity

1. Introduction

In the past years, direct-view type reflective LCD is becoming more and more attractive owing to its low power consumption, lightweight and good outdoor readability. So reflectivity is much critical for reflective LCDs. However, conventional reflective LCD is not satisfied due to its low reflectivity, this is mainly because conventional reflective LCDs have the double polarizers configuration. Moreover, the external reflector causes serious parallax problem. Obviously, reflective with single polarizor has much advantages than double polarizors. Indeed, in the past 2-3 years, many reflective LCD modes with single polarizor have been developed, thereinto, some types have been realized volume production. Because of diverse device structure, these models have the different characterizations and working performance. In order to improve their performance, the advantage and deficit in the configuration, material, characterization, cost of them have been studied in the past, and some valuable results have been received.

2. The configuration and displaying mode of reflective LCDs

Just now, there are two typical structures with regard to reflectors. One is a diffused reflector inside a panel and the other is a mirror reflector inside a panel with a front scattering film in front of the panel. The former is more suitable for achieving high-quality reflective-color TFTLCDs without faint images.

On the other hand, the number of polarizors in reflective LCDs may be different depending on its configuration. In addition, the different LC mode such as STN, ECB, OCB, G-H, PCGH, PDLC,PSCC etc, can be employed in reflective LCDs. In general, there are twenty device structures in reflective LCDs. The following table describes some important reflective LCDs with their performance. These reflective LCDs have their own characteristics, and each of them could find their especial application fields.

It is well known, reflectance, contras and chromaticity are the important characteristics for Reflective LCDs, because they determine the visibility of Reflective LCDs. The illumination effect is depenent on how the light source is used, whether as a spot or as an area. So, in the all types which is described in the following table, the GH type and PDLC(Polymer Diffuse LCD) refelctive LCDs (Gost-Host) have the better performance . In addition, α -N* GH (amorphous Nematic Gost-Host LCD is the best in all the types.

The performance comparison of various mode of reflective LCDs

Mode	Polarizor	Reflectivity	Contrast	View angle	Gray scale
TN	2	Poor	Good	Poor	Good
STN	2	Poor	Good	Poor	Good
R-STN	1	Common	Good- Common	Poor	Good
ECB	1	Common	Good- Common	Poor	Good
G-H(double layers)	0	Good	Common	Good	Good
W&GTH	0	Good	Common	Good	Poor
α -N* GH	0	Good	Common	Good	Good
PDLC	0	Common	Poor	Good	Good

3. Some representative reflective LCDs and their technologies

Although a few of reflective LCDs have been developed in the past, and now some new types also are being developed, the following types of reflective LCDs are attracting more and more engineers because of their distinctive advantages. In other words, comparing the other reflective LCDs, these types seem to have the bright future.

3.1 Vertically Aligned Reflective-Color TFT-LCDs

It is well known, lower contrast is the major challenge for reflective LCDs. In order to improve the contrast ratio, eliminating residual retardation and simple alignment in the black state is a good way. Under this situation, VA(vertical Aligned)-LCDs is a better choice. Comparing the common TN-LCD, VA models have the much simple alignment in the black state. Besides the higher contrast, the reflectivity of VA models is superior to common TN models. Moreover, the VA structure is allowed to use photolithography to obtain the diffusing reflector, so the exposing process could be simple by one step process. By employing VA models, the contrast ratio and reflectivity can be enhance to 80:1 and 42%, respectively.

3.2 Reflective STN-LCDs with single polarizor

Reflective STN-LCDs have some potential advantages, such as low cost, simple configuration, lower investments, etc. However, in the conventional reflective STN-LCDs, the LC layer is in located during the two polarizors, so the incident light and reflective light would pass a long distance by passing through many layers which is behind the filter and LC layer. Under this situation, parallax of the device maybe much prominent and the image color purity is low.

To solve this problem, new reflective STN-LCDs have been developed. Among of them, the representative configuration is only one polarizor is used and there are 1 or 2 retardation films in these refective STN-LCDs. By computer simulation, this type of reflective STN-LCDs' performance can be optimized much more.

3.3 A new single polarizor reflective LCDs based upon IPS and RTN mode

At the present time, Reflective Twisted Nematic mode (RTN) is growing very fast, because it has higher contrast and solve the problem of critical requirement of thin cell gap. However, RTN models

also have inherent difficulties, such as lower response speed due to its too large optical retardation value and serious color dispersion ,especially at intermediate grayscale scales. To overcome above deficits for RTN, the new model which is based on the RTN and IPS(In-Plane Switching) is developed. This new structure has much lower color dispersion and wide viewing angle.

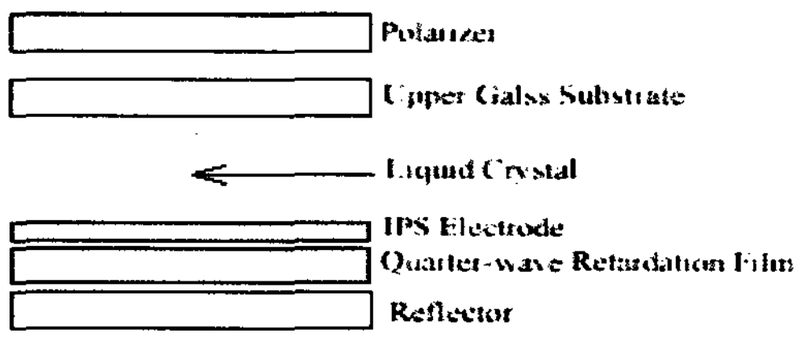

Fig. The schematic diagram of R-IPS LCD with single polarizer

3.4 The other types of newly developed reflective LCDs during the past 2-3 years

Besides the types which is discussed above, there are some other types of newly developed reflective LCDs, such as reflective GH-LCDs (with polarizor or without polarizor), reflective Antiferroelectric LCDs(AFLCD), diffuse reflection LCDs, holographic polymer disperse LCDs, front-scattering reflective color reflective LCDs, reflective LCDs withg plastic substrate, etc.

A promising technology development in reflective LCDs is that adopting the novel refector—which is called Random Grating Reflector. Some researcher found that the transflective LCDs using random grating reflector provides more uniform reflected light within typical viewing region from 0 to 25° , with high brightness and high image quality.All of them have their own advantages, so it is valuable to research these new models to improve their performance.

4.Conclusions

The technology of reflective LCDs is growing very fast in the past years. In some fields, some important progress have been achieved. Among of them, single polarizor technology, high reflectivity TFT-LCDs technology, adopting some advanced LCD technology such as VA, IPS in reflective LCDs maybe the representative developing direction. Generally speaking, single polarizor and none polarizor technology has the bright future.

Although the technology of reflective LCDs is not mature enough, and some key issues in reflective LCDs has not to be resolved at present time, such as low brightness, narrow viewing angle, non-uniform reflected light distribution of the reflective pixels, low optical efficiency, different response time, and inadequate color saturation of the transmissive pixels. But In fact, no one would doubt that reflective LCDs with high performance is the one of the fastest growing market in the near future, especially for cell phone and handheld devices application.

5.References

[1] Zhu Xinyu, Jing Hai, Yang Bailiang, Ling Zhihua, Huang Ximin, ASID'00 Proceedings, p350-355

[2] Yoshio Koike, N. Sugiura, K. Ohmuro, IDMC'03 Proceedings

[3] Genyu Ying, Wenbo Hu, etc, Flat Panel Display Technology (2002 version), Post and Telecommunication Press, China