Enhanced Super-IPS Display Performance in large size TV application

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Abstract

*Super **I**n **P**lane **S**witching (S-IPS) technology is applied for large TFT-LCD panels used in TV applications. It has a lot of advantages in comparison to the alternative, VA technology. S-IPS shows excellent viewing angle properties and fast response time between intermediate gray levels. If the performance parameters which describe the actual visual performance are considered, S-IPS is much more advantageous.*[1)]

However, it shows relatively low contrast ratio in diagonal direction compared to viewing angle characteristic in upper/down direction in S-IPS.

In order to compensate the relatively low diagonal contrast ratio, Super-IPS applying for optical film developed, but Super-IPS still has the problem of color shift in black pattern. [2)]

So we improved this problem by developing Enhanced Super-IPS.

Introduction

Several types of display like flat-CRT, PDP, LCD are competing with each other for emerging HDTV market. It looks that PDP is a promising candidate for the leading display of HDTV because of efficient manufacture together with the desirable features of a flat panel display although it does have some resolution limitations. But increasing manufacturing glass size enables manufacture of LCD panels with more than 40 inches diagonal which can compete effectively with PDPs. Table 1 compares the specification of several display types including LCD TV and PDP TV. It is noticeable that PDP shows response property of micro seconds, because of the intrinsic property of impulse devices. On other hand, the resolution of PDPs is not as high as that of LCDs. Although the viewing angle characteristics of super IPS are good enough for TV applications, it is necessary for IPS products with large screen size more than 40" to get additional viewing angle improvement especially for diagonal direction without Color Shift. If it is competed PDP or other Flat panel Displays, the TFT LCD is required a free of Color Shift in Black PTN.

	Requirement	LCD TV	PDP TV	CRT TV	Projection TV
Size	20"~	~52"	30"~60"	10"~40"	40"~
Space	Small	⊙+	⊙	△	△
Resolution	SVGA~	⊙+	○	○	○
Response Time	~16msec	○→⊙	⊙	⊙	⊙
Viewing Angle	>170°	○→⊙	⊙	⊙	⊙
Brightness	450nit~	⊙	○	⊙	○
Power Consumption	~100W	⊙	△	○	△
Life Time	50,000hrs~	⊙	△	⊙	○

(⊙ : High ○ : Average △ : Low)

Table 1. The comparison of LCD and PDP

Principal of light leakage and color shift in S-IPS

The light leakage from crossed polarizer is explained as follows (Fig.1). Generally, if two polarizers are stacked with their absorption axis at azimuth $\phi = 0°$ and $\phi = 90°$, respectively (crossed polarizer), and one observes them from the plane at azimuth $\phi = 45°$, the effective angle between the absorption axes of the two polarizers increases with the polar angle of the observing direction.[4~6)] That cause light leakage occur. Also wavelength dispersion occur color shift.

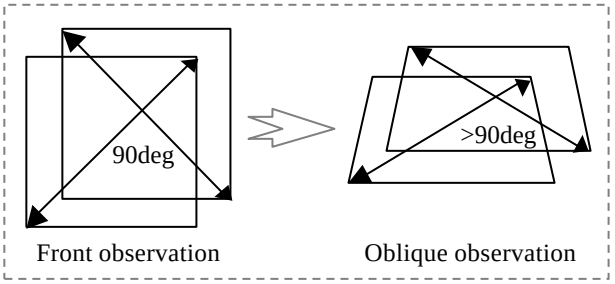

Fig.1. A principal of light leakage in the crossed polarizers

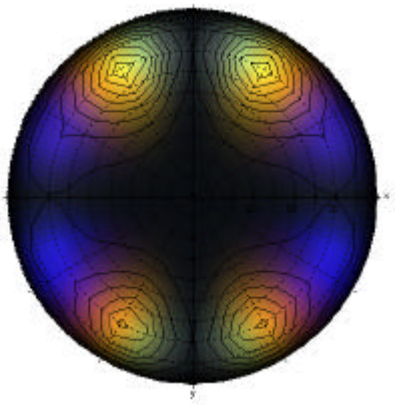

Fig. 2. Brightness of Black state in S-IPS

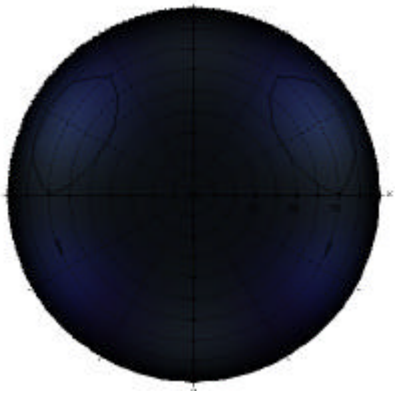

Fig. 3. Brightness of Black state in Enhanced Super-IPS

Experiment

Simulation of IPS & Enhanced Super-IPS

Chen et al.[3] have shown a combination of a positive A plate with a positive C plate (or a negative A plate with a negative C plate). We utilized the method proposed by Saitoh et al. [5] for compensation by one biaxial film

As a reference we simulated the viewing angle of S-IPS with no compensation film, which shows a reasonably wide viewing angle (Fig .2)

Also we simulated using advanced compensation film. We verified lower black luminance and color shift at diagonal direction than Super-IPS.[2]

Actual results of Viewing angle and color shift for Enhanced Super-IPS

Using a Enhanced Super-IPS with the compensation films and a panel filled with Merck liquid crystal mixture with birefringence of 0.08, the viewing angle was measured. The viewing angle dependence and color shift of S-IPS is shown in Fig. 4. And increasing viewing angle and much lower color shift for Enhanced Super-IPS is depicted in Fig. 5.

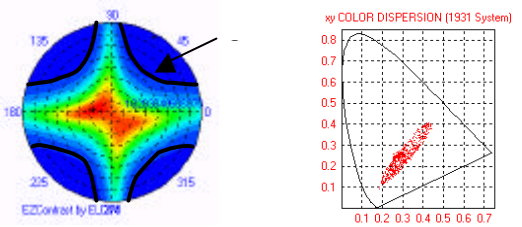

Fig. 4. The viewing angle and color shift of S-IPS

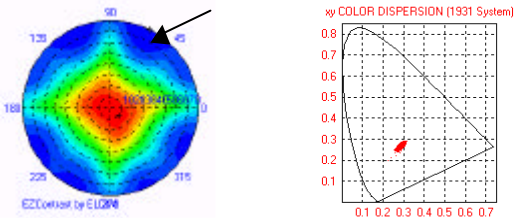

Fig. 5. The viewing angle and color shift of Enhanced Super-IPS

Results and Discussion

We investigated the optical properties of biaxial optical compensation films and Enhanced Super-IPS has a reduction on color shift using new compensation film and technologies. We believe that Enhanced Super-IPS applying for the new compensation design can be presented a real image.

Acknowledgement

We heartily thank for the Nitto Denko Corp, which is supplied the biaxial film to fabricate in Enhanced Super-IPS of 32 ~ 47-inch. And also we specially appreciate the help of Mr. Yoshimi, Mr. Yoda & Mr Kawai.

Reference

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[7] see " Optical Films for Liquid Crystal Display Data Sheets" from Nitto Denko.