Improve the Gamma variation by monitoring the angle of the polarizer absorption axis

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Abstract

Gamma curve is one of the most important optical performance characteristics of a liquid crystal display. we present investigations on the relationship between gamma and polarizer. The gamma curve is affected by the angle of the polarizer absorption axis. When the crossed angle between the two polarizers turns larger, gamma values will decrease. The gamma variation caused from each polarizer variation could be improved by monitoring and controlling the axial direction of the polarizers.

1. Introduction

Gamma is one of the most important optical performance characteristics of display[1]. The gamma curve of LCD is affected by the liquid crystal material, cell gap and pixel structure, reference voltages, pretilt angle, the angle of the polarizer absorption axis , thickness of PI , and other factors. Even though these factors may be fixed from a design standpoint, gamma values of mass-manufactured LCD panels have a very wide distribution from the target gamma due to process and material variation.

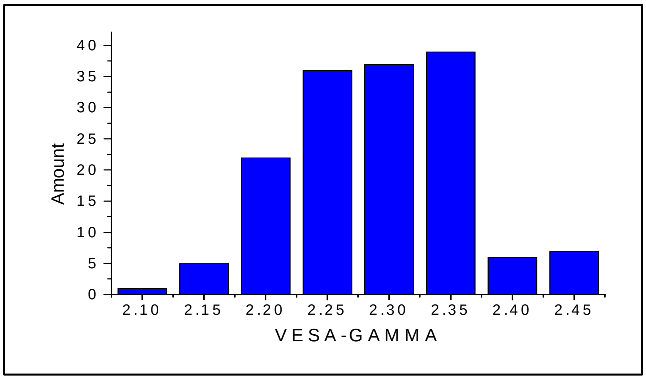

Fig. 1 Shows a typical spread of gamma values for mass-produced.(Designed gamma is 2.2)

In the past we have clearly understood the manufacturing factors and materials influences the degree of gamma variation. In general, we would not relate the polarizers to gamma values, we didn't find an obvious relationship between the polarizers and the gamma values. Because we couldn't precisely control polarizer absorption axis in past.

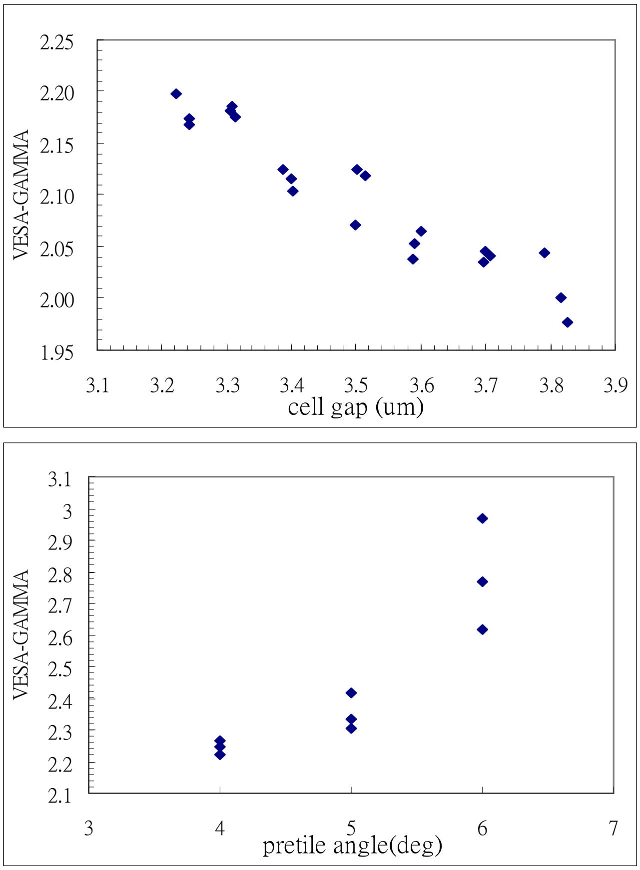

Fig. 2. Shows what degree the influences of some varied manufacturing factors on the gamma values of mass-manufactured panels

So we study the relation between axial direction of the polarizer and the gamma values. The value changes because the absorption axis of the polarizers is subject to change when they are cut by the suppliers. And polarizers are provided by different suppliers, or of different batch would be different in their axial absorption.We now focus our study on the relationship between the axial direction of the polarizers and the gamma value, in hopes that we would gain more knowledge about how to control the various manufacturing procedures and material factors which cause the variation of gamma values.

2. Experimental

The experimental device was shown in Fig 4, where the LCD was placed between two pieces of precisely controllable polarizer. We use a laser beam as a light source, and detect its intensity using a detector after the beam penetrates the LCD and the polarizer.

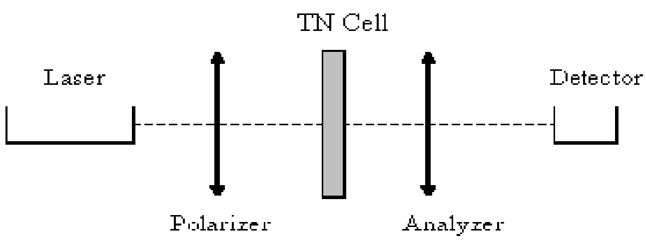

Fig. 4. Schematic diagram of the optical measur ement system

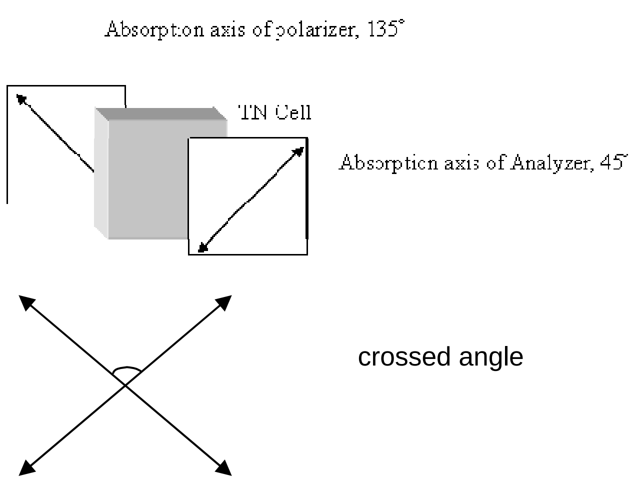

Fig. 5. Shows the status of the polarizer. The polarizer is at an absorption axis of 135 degrees, and the analyzer is at an absorption axis of 45 degrees, which means their crossed angle stays at 90 degrees.

The measurement of TN panel is taken by the range from 0 to 255 gray scale, and each is taken for every 16 gray level, (which are 17 measurements in total). After the measurements are made, we calculate the gamma values, the 17 difference luminance symbolize, according to VESA definition. After this stage, we fix the polarizer, and at the same time make the analyzer rotate from 86 to 94 degrees and measure at each 0.2 degree. The 17 gray scale luminance of the panel between the two polarizers, and then turn each gray level into a gamma value. From all these gamma values converted from measurements, the relation between crossed angle and gray level were shown in Fig. 6(a) and Fig. 7 showing the relation between the crossed angle and gamma.

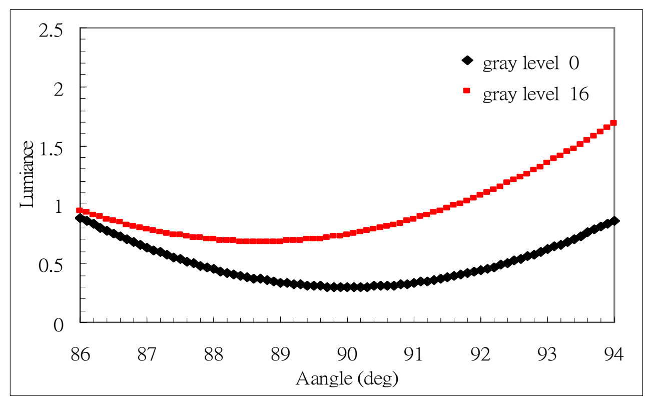

Fig. 6(a)The relation between crossed angle and gray level of 0 and 16

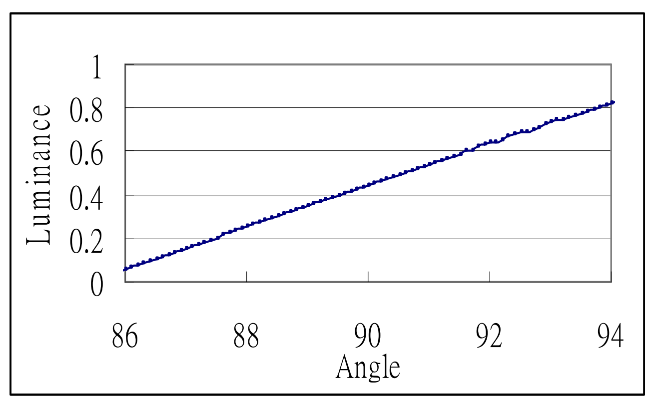

Fig. 6(b).The defference luminance of level 16 and level 0(We set the polarizer and analyzer crossed. This angle between polarizer and analyzer is determined 90 degrees)

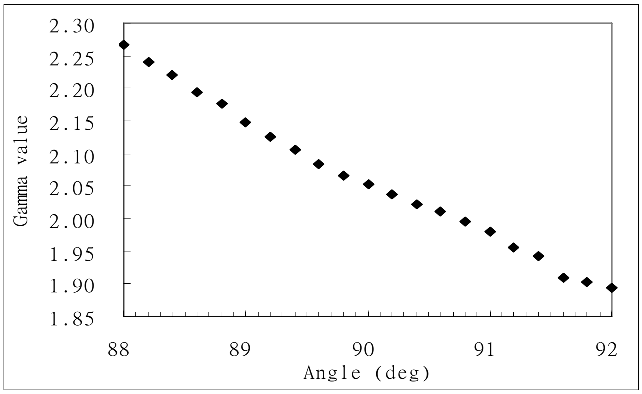

Fig. 7. The crossed angle between analyzer and polarizer VS gamma value

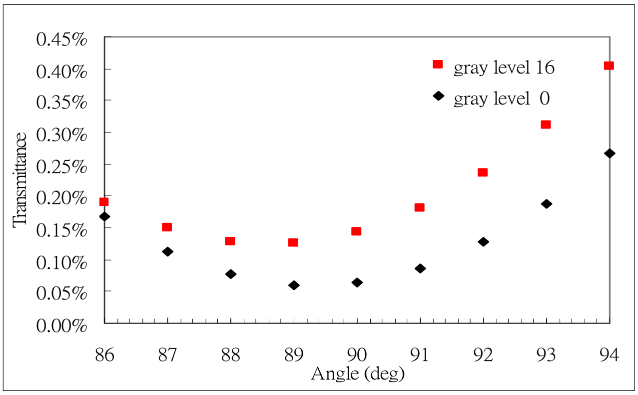

Fig. 8. The crossed angle between polarizer and analyzer VS the gray level of 0 and 16(polarizer 135°, Analyzer 45°) .

3. Results and discussion

The simulated result is the same as the experiment's.which the influence of the axial angles upon gray level 0 and 16 are shown in Fig 8 . The gray level changes with the crossed angle, however, the luminance does not change symmetrically. This is due to the polarized light emitting out from the panel, either major axis or minor axis, is not aligned precisely to the Analyzer, as Fig.9 shows.That is when the analyzer rotates clockwise around the axis can only allow more light to pass. And when it rotates counterclockwise, less light will be allowed to pass in the first place, but more light will pass when the polarizer is rotated past the minor axis, as shown in Fig.9. By simulation, rotate both the polarizer and analyzer by 90 degrees around the axis at the same time or rotate panel by 90 degrees, that we could obtain the expected relationship, which is the same tendency, as shown in Fig.10. The elliptic polarization light created by different gray level would have different minor-axis angles. That's why the minimum brightness of different gray level would correspond to different rotation angles of the polarizers, from which each gray level polarization state may be obtained.

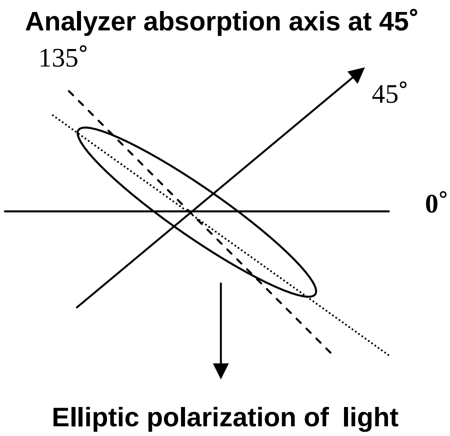

Fig. 9 The crossed angle turns small is represent analyzer rotate counterclockwise.

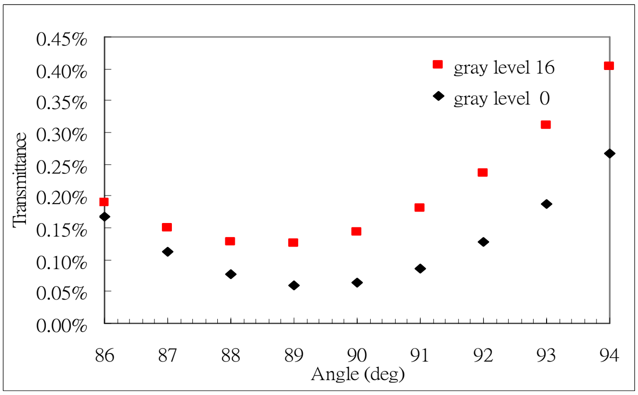

Fig. 10. The crossed angle between polarizer and analyzer VS the Gray level of 0 and 16 (polarizer 45°, Analyzer 135°)

4. Summary

This paper focuses on the influence of absorption axis of polarizer on the gamma values, and result of simulation proved the causes. Therefore, the gamma variation caused by the variation of polarizer could be improved by monitoring and controlling the axial direction of the polarizers. And, as we have already known that gamma values of different panels will be influenced differently by the axial direction of the polarizers, we can now try to find the panel of which the gamma value would change at the least degrees at different axial directions.

5. Acknowlegements

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6. References

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