Development of Polarization Controlled Micro Transmittance Profiler

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Abstract
We report the development of the equipment that can measure the transmittance of the polarizer for TFT-LCD application versus azimuth angle of the linear polarization at each micro spot in the section, and therefore measure the degree of iodine permeation and alignment quantitatively at each area of the section.

1. Objectives and Background
The general method of manufacturing dichroic polarizer for TFT-LCD application is to stretch PVA(Poly Vinyl Alcohol) in the iodine aqueous solution such that iodine permeates into PVA from its surface. [1,2] If the permeation and alignment of iodine is not complete, the permeation and alignment of iodine in the center area of the section of PVA becomes poorer than that in the surface area, and therefore the transmittance of the crossed polarization in the center area becomes higher than that in the surface area, which results in degraded overall polarization of the polarizer.
Until now, the degree of iodine permeation and alignment uniformity has been verified usually by observing the section of the polarizer through polarization microscopes, which of course cannot give the quantitative information about transmittance at each area of the micro section. In this presentation, we report the development of the equipment that can measure the transmittance at each micro spot the section of the polarizer for TFT-LCD application, and therefore measure the degree of iodine permeation and alignment quantitatively at each area of the micro section.

2. Equipment and Analysis
2.1 Development of Equipment
The equipment manufactured for measuring the degree of iodine permeation and alignment quantitatively at each area of the polarizer has the measuring wavelength range from 400 nm to 700 nm, and 0.1 μm position movement resolution. It uses 1 μm spot size aperture so that the transmittance at each 1 μm spot area of the section of the polarizer can be obtained. It also has the internal setup that can control the azimuth angle of the linear polarization of light incident on the sample, so that the degree of polarization at each micro section of polarizer is obtained. With the genuine use of the neutral density filters, the equipment shows the accuracy of measuring the degree of polarization up to 99.99 %.

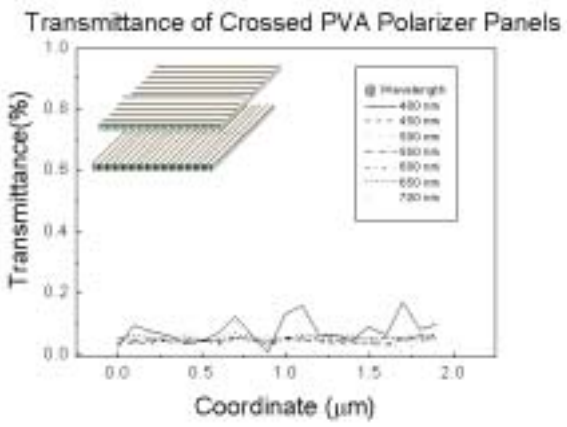

Figure 1. Measured transmittance with the two crossed polarizer panels.

We measured the transmittance of the PVA polarizer with two crossed polarizer panels. Figure 1 shows the measured transmittance with varying the wavelength of the incident light from 400 nm to 700 nm. Especially, It shows the very low transmittance(i.e, below 0.05%) in the spectral range from 450 nm to 700 nm.

2.2 Analysis of Sample.

The sample polarizer was sliced with 2 μm size and the sliced one was put on a slide glass. It was soak in the liquid that matched with PVA refractive index. The total length of the sliced section was about 30 μm and the length of the each iodine permeation area of the section was 8 μm**.** The transmittance measurement was carried out using a objective lens of 40 magnification at each 1 μm spot size area, with 0.1 μm position movement. Varying the azimuth angle of the linear polarization of incident light on the sample, the transmittances both at orthogonal polarization and at parallel polarization were measured.

3. Results

Figure 2 shows the image of the sliced polarizer sample at each different linear polarization of incident light.

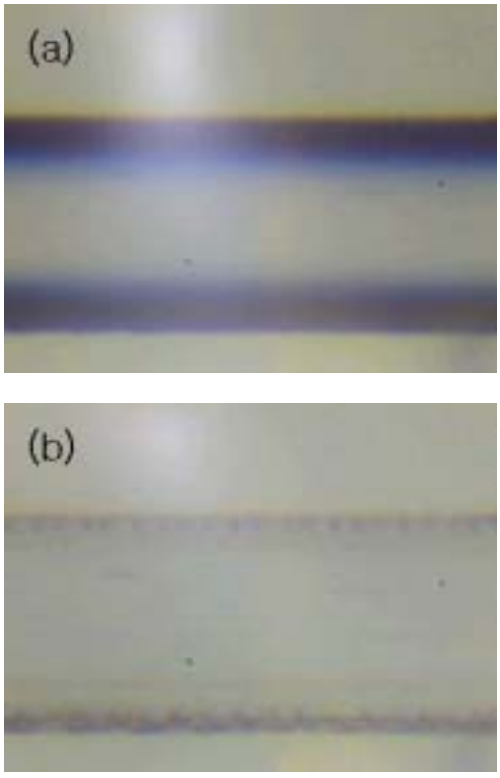

Figure 2. (a) The orthogonal polarized light is incident on the sample. The iodine permeated areas in the section of the sample look dark. (b) The parallel polarized light is incident on the sample. The iodine permeated areas look brighter than those of (a).

When the orthogonal polarized light is incident on the sample, it is observed from Figure 2(a) that only iodine permeated areas in the section of the sample look dark. When the parallel polarization light is incident on the sample, it is observed that iodine permeation areas in the section of the sample look brighter than those of Figure 2(a). Using the color image, it is seen that Figure 2(a) has blue tone color at the iodine permeation area. It means that the sample becomes more transparent at the shot wavelength range (i.e, 400 nm to 500 nm) than the long wavelength range.

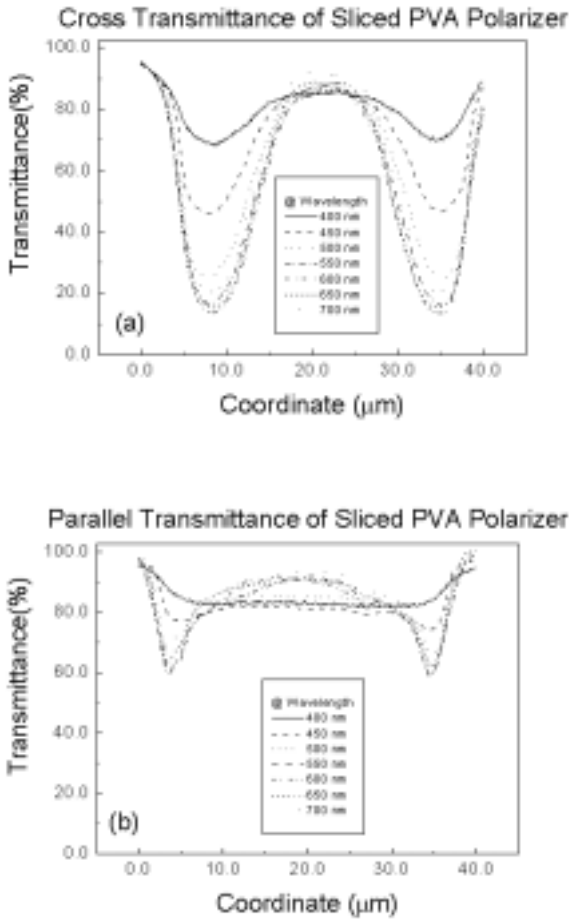

Figure 3. The measured transmittance using micro spot and micro moving system. (a) Transmittance of sliced PVA polarizer sample with orthogonal linear polarization. (b) Transmittance of sliced PVA polarizer sample with parallel linear polarization.

Figure 3 shows the transmittance at each micro spot in the section of the sample, scanning from upper iodine permeation area to down iodine permeation area with 0.1 μm movement. The graph shows that the center

area of the section gives high transmittance, which is due to the fact that iodine is not permeated in the center area of the section as shown in Figure 3. At a fixed point, the transmittance shows huge wavelength dependence. Figure 3(a) shows measured transmittance of sliced PVA polarizer with orthogonal linear polarization of incident light. It is observed that the polarizing effect of the aligned iodine is greatly reduced at short wavelengths. Figure 3(b) shows measured transmittance of sliced PVA polarizer with parallel linear polarization of incident light. It is observed from Figure 3(a) that has a minimum transmittance about 13% is obtained at the position of 8 μm and 35 μm.

4. Summary

We developed the equipment for TFT-LCD application, that can measure the transmittance of the polarizer versus azimuth angle of the linear polarization at each micro spot in the section, and therefore measure the degree of iodine permeation and alignment quantitatively at each area of the section. It has a 1 μm spot aperture with 0.1 μm movement. It can resolve the transmittance of the polarizer with 0.01% difference, which is below 0.1%.

5. References

[1] Racich et al., Proceedings of SPIE, vol. 464, Jan. 26-27, (1984).

[2] James L. et al., United States Patent 4,591,512, May, 27, (1986).