Laser -addressing Electronic Paper

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Keywords : ChLC, Display, Laser Addressing, r-Paper

Abstract

A new laser-addressing method is proposed in this paper. With the characteristic of high power and small spot size, simple structure electronic paper can be addressed only by laser source, and high quality image with 300dpi resolution can be easily achieved.

1. Introduction

Due to paper-like look and ultra-low power consumption, ChLC (Cholesteric Liquid Crystal) panel are widely investigated in recent years [1]. However, with the restriction of panel cost and image quality, flexible ChLC panel is very hard to compare with conventional paper in a wide range of documents.

R2R (Roll-to-Roll) process is an economical method to reduce ChLC panel cost [2], but it still takes laser-etching or inkjet-printing process to produce patterned electrodes. Moreover, patterned electrodes cause the imperfection of low resolution which highly limits the application of ChLC display. For these reasons, many photo-addressing techniques [3, 4] have been developed recently. Through the light source high quality image can be easily achieved in a panel without patterned electrode and manufacturing process is substantially simplified.

In this paper, a new driving method of laser-addressing is proposed to directly drive ChLC Panel and reach 300dpi resolution image, without applying additional voltage. And this driving procedure allows us to erase and write images at unlimited times. This method can not only simplify panel process and driving system but also accelerate the popularity of ChLC e-Paper.

2. Experiment

2.1 Panel Structure

In SID 2006, electro-optical Cholesteric sheet writing method was previously proposed [5]. Figure 1 is the sectional diagram of the standard developed flexible electronic display. The displays were produced by using a narrow-width R2R laser etcher to segregate the bottom electrode of ITO on PET, and a narrow-width continuous-coating machine to precisely deposit and dry the cholesteric liquid-crystal droplets, dispersed in a water soluble binder layer (PDLC), and a dark layer (DL), and by screen printing thermally cured conductive, polymer thick film inks to form the top conductors (Ag) and interconnect pads (Ag).

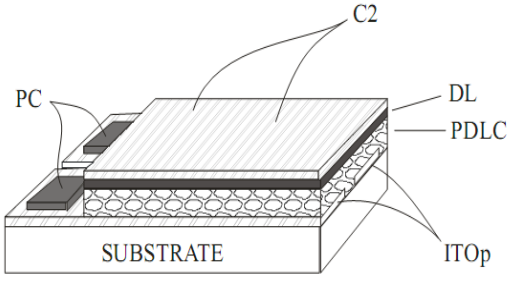


Fig. 1 Flexible ChLC display structure [5].

In the near future, laser addressing may be adopted to initialize the ChLC panel, then the two-wire power supply for the flexible displays can be omitted, and the ChLC display can be driven and initialized only by one laser source. Then, the thin electrical conductors of panel also can be omitted, and low cost, simple

rewritable labels with high information content will be provided.

2.2 Laser –addressing Theory

Figure 2 plots reflectance of a display sheet after being initialized to a planar state and exposed through a mask to a flash pulse at various applied voltages [5]. The exposed light applies thermal energy to the dark layer and increases the heat of ChLC layer. The thermal pulse shifts the electro-optical response curve of exposed areas to lower voltages. With the characteristic of high power, laser source can provides enough energy to address ChLC panel at zero voltage. ChLC could be transferred form Planer state to Focal conic state or form Focal conic state to Planer state.

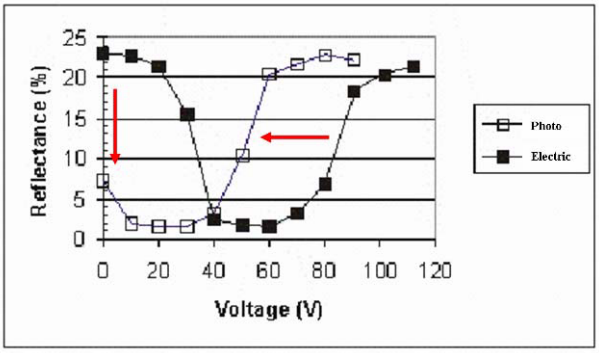


Fig. 2 The electro-optical response of ChLC [5]

2.3 Experiment setup

Figure 3 is the experiment setup in this paper. This paper adopts 1064nm IR laser source because it's cheap cost and stability. Laser light is guided to the collimator through a fiber. The collimator will control the spot size. Then the x-y scanner mirrors will control the scanning method to address the designed patterns.

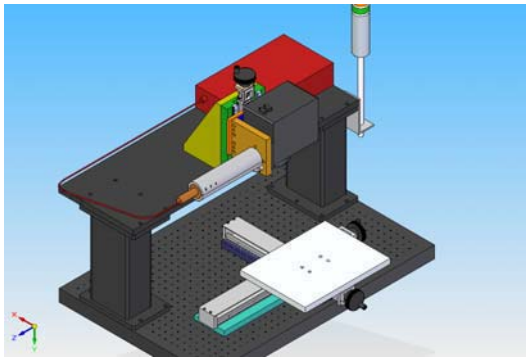


Fig. 3 Experimental test setup

There are two kinds of laser driving mode: pulse mode and CW mode. Pulse mode is used in this experiment beacuse the CW mode driving will easily damage the panel (Figure 4).

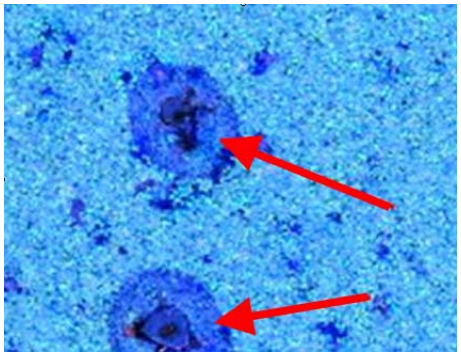


Fig. 4 Damage points on panel with CW driving mode

3. Results and Discussion

3.1 Results

Through the power modulation experiments, this paper finds the reflectance decreases with the increasing laser power, as shown in Fig. 5, and the trend is stopped at 1.7W. The reason is the energy is too large to damage the panel. In Figure 5, it also shows experimental results of laser frequency modulation experiment. Laser with lower frequency has better performance between 1.2W and 1.7W.

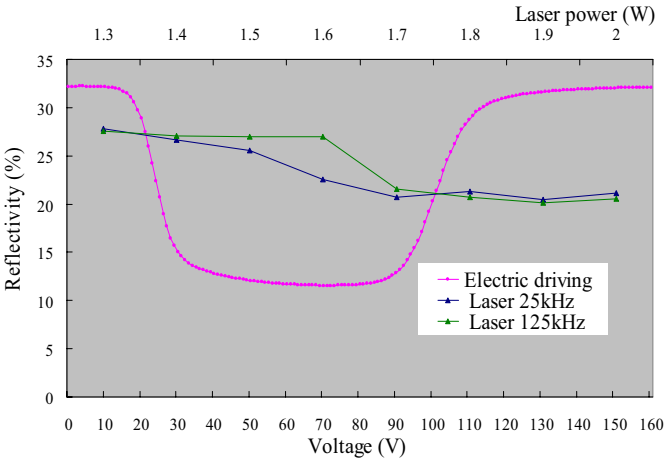


Fig. 5 R-V and R-P Curves of the ChLC Display

With laser-addressing technology, ChLC panel could be driven in different initial state. In initial P state, the contrast is 1.8 and in initial F state the

contrast is about 1.3. So, in most cases we laser-address CHLC panel in initial P state, the result is showed in figure 6 and figure 7.

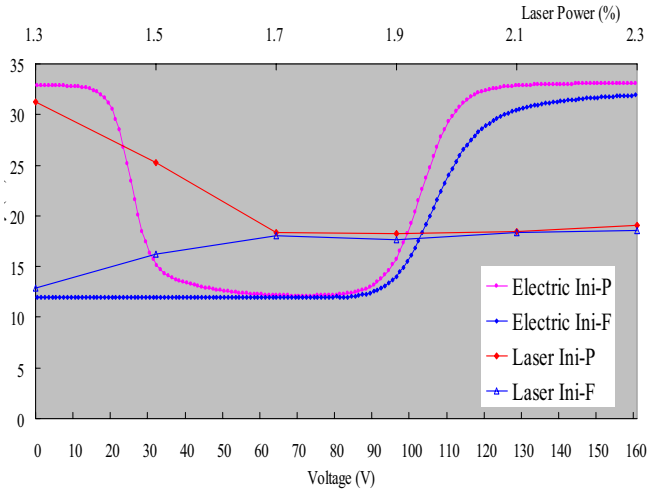


Fig. 6 P-V curve indifferent initial State.

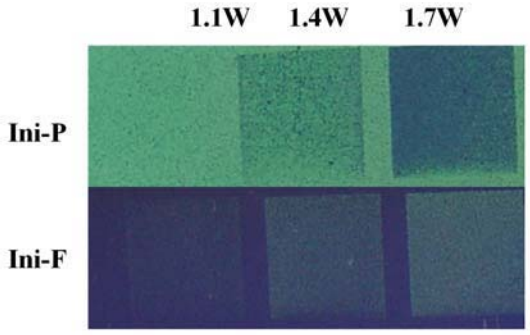
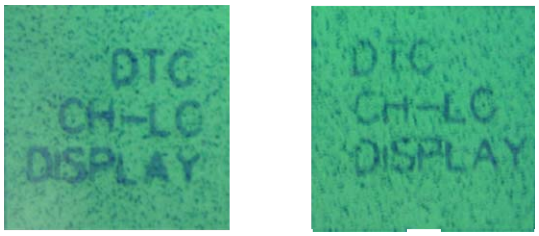


Fig. 7 Laser-addressing result in different initial states.

Laser addressing can not only drive panel from the front side, the transparent PET substrate, but also from the backside side, nontransparent Ag electrode. However, backside laser-addressing takes larger energy, and diffusion of thermal effect become more complicated. As figure 8 shows, the line image addressed from back side is more thick and blurred.



(a) (b)

Fig. 8 (a) Back driving (b) Front driving

3.2 Discussion

Laser-addressed e-Paper can be driven only by laser without additional applying voltage, and with this method panel structure and driving system can be simplified. However, there still exist low contrast and slow writing speed issues to be overcome. The approaching solutions might be driving parameter optimization and new photosensitive dark layer material development to enhance the absorption of laser. Although 2W laser power is too large to commercialize laser-addressing now, we still believe, according to the addressed images, laser-addressing is potentially a excellent method to driving ChLC e-Paper.

Fig. 9 Laser-addressed images (Panel Size 3.5” x 4.5”, 300dpi)

4. Summary

Laser addressing has the advancements of maskless system, high resolution image quality, large driving area, and zero-driving voltage. In the future, laser-addressing may be adopted to initialize the ChLC panel, then the two-wire power supply for the flexible ChLC displays could be omitted, and the ChLC display can be driven and initialized only by one laser source. Then, the thin electrical conductors of panel also can be omitted, and low-cost and simple rewritable papers with high information content will be provided.

5. References

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