Color Pixelization of Cholesteric Materials

L.-C. Chien, F. Vicentini, Y. Lin and U. Müller
Liquid Crystal Institute and NSF ALCOM Center
Kent State University, Kent, Ohio

Abstract

A bistable color reflective cholesteric display (RCD) is developed, using a unique cholesteric materials containing a tunable chiral material (TCM). The chirality of such cholesteric materials can be altered using phototuned lithography. The pitch length of each region can be tuned to reflect a different color, thereby creating different color pixels in the liquid crystal material itself.

Introduction

Full-color flat panel displays are essential for the development of new devices such as signs, electronic viewers, notebook computers and video displays. It has not yet been possible to make a full color liquid crystal display without the use of passive color filters or other dichroic devices.[1-5]

Cholesterol liquid crystals in the planar texture possess the unique optical feature of separating incident white light into its left- and right-hand circular components by reflecting one component and transmitting the other. The wavelength of the reflected component is given by the Bragg formula $\lambda = np$, where n is the average refractive index and p is the pitch length of the cholesteric helix. When the λ is in the visible light range, the material provides beautiful iridescent colors. The wavelength of the reflected light is easily controlled by adjusting the chemical composition which changes the chirality of the material and therefore p. The reflected wavelength can also be made temperature independent over wide temperature ranges by using suitable chemical mixtures and polymer networks.

Color Patterning and Reflective Cholesteric Displays

We developed a unique method to produce full color RCDs utilizing a tunable chiral material (TCM) in conjunction with photolithography to pixelize the three primary colors for a full color reflective display. As described above, the Bragg reflective colors are phototuned by control of the pitch length. Subsequent ultraviolet radiation alters the chirality of the tunable chiral dopant and thus adjusts the chirality of the cholesteric mixture. The reflection wavelength of the PSCT is then controlled by the amount of UV exposure. Figure 1 shows the photo-tuned reflection wavelength versus the dose of UV radiation.

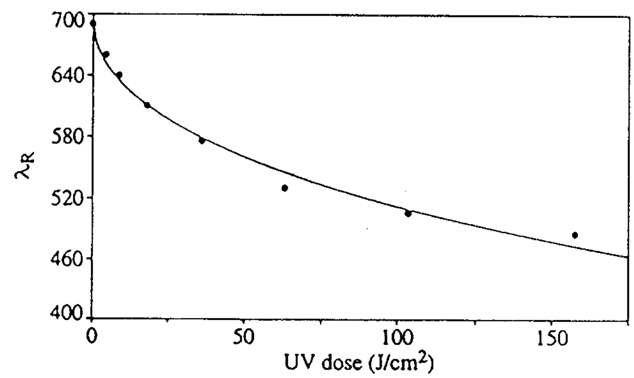

Figure 1. The reflection wavelength versus the UV dose

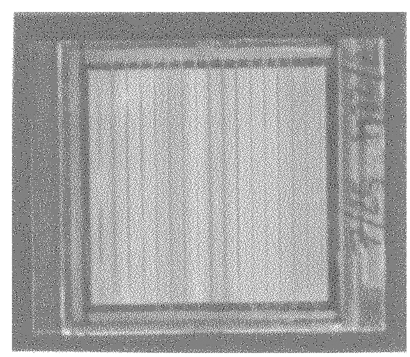

Figure 2. The pixelized multicolor reflective cholesteric display.

To reduce the threshold voltage, there is a need to use high helical-twisting power TCM to extend pitch change across the color spectrum in a full color reflective display. In practical application, the full color reflective cholesteric display does not require a color filter. Therefore, the manufacture of low-cost and low power consumption full color reflective LCDs is possible.

Multicolor RCDs were prepared using an ITO and polyimide coated cells which were antiparallely rubbed and separated with 5 micron glass fiber spacer. A display cell prepared from a mixture of 94.5% of cholesteric mixture (prepared from E48, CB15, CE1 and R1011) and 5.5% of TCM additive reflects iridescent blue color. The photo-tuned color proceeded with high intensity UV radiation. The UV exposure changed the chirality of a cholesteric mixture and thus, adjusted the pitch of the cholesteric mixture. Figure 2 shows a pixelized reflective cholesteric displays which reflects the three primary colors.

Acknowledgement

The research is supported in part by ARPA/LOW POWER DISPLAYS Contract #N61331-94-K-0042. The authors thank Don Davis for the lithography masks and display cells preparations.

References

1. D. K. Yang, L.-C. Chien, J. W. Doane, *Conference Record, International Display Reserach Conference*, p. 49 (1991).
2. J. W. Doane, D. K. Yang, L.-C. Chien, *Conference Record, International Display Reserach Conference*, p. 175 (1991).
3. D. K. Yang, L.-C. Chien, J. W. Doane, *Appl. Phys. Lett.*, **60**, 3120 (1992).
4. D. K. Yang, J. L. West, L.-C. Chien and J. W. Doane, *J. Appl. Phys.*, **76**, 1331 (1994).