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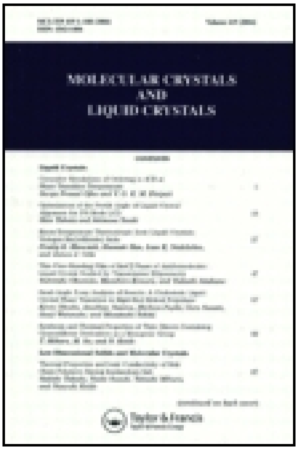

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Reflective Bistable Cholesteric/Polymer Dispersion Display with a Black Polypyrrole Electrode Cast from the Solution

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Reflective Bistable Cholesteric/Polymer Dispersion Display with a Black Polypyrrole Electrode Cast from the Solution

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A reflective mode bistable cholesteric/polymer dispersion(CPD) display is proposed in which both the electrode and the light-absorbing layer of the conventional display were substituted with a single polypyrrole(PPy) layer spin-cast from the chloroform solution. Utilization of the black conductive PPy film coated on the inner surface of the rear glass plate not only provided a convenient and economic method of fabricating CPD displays but also improved the contrast ratio by about 20%. By incorporating 20% of polymer into the chiral nematic mixture, the bistability and the viewing angle of the display were remarkably enhanced while the reflectance decreased from 89 to 29%.

Keywords: soluble polypyrrole; reflective bistable cholesteric display

INTRODUCTION

Reflective cholesteric liquid crystal displays(LCDs) have attracted much attention because they are low-power lightweight flat panel displays(FPDs) ideal for use in portable information devices[1]. Moreover, the displays are naturally adaptive to changes in ambient illumination and do not require expensive active matrix addressing techniques. Recently, to meet the needs for rugged flexible FPDs, a conducting polypyrrole(PPy) film formed on a poly(ethylene terephthalate)(PET) substrate has been tried as the electrode because the polymer electrode is more flexible and shows a better adhesion with the PET substrate on bending than the indium-tin oxide(ITO) electrode[1~3].

PPy has been known to be infusible and insoluble in organic solvents and, therefore, the film has been formed by the electrochemical polymerization on an electrode surface or by the in-situ chemical polymerization on substrates[2]. In this work, we employed the soluble PPy technique[4] to prepare a PPy-coated black glass substrate and demonstrated the reflective bistable chiral nematic mixture(CNM) and cholesteric/polymer dispersion(CPD) [5] displays made possible by using the substrate.

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EXPERIMENTAL

PPy solutions in chloroform with a concentration range of 1~7 wt.-% were spin-cast on normal glass plates to give a very smooth surface. The PPy film was turned insoluble in organic solvents by a thermal treatment at 90 °C for 30 min. Utilizing the substrates coated with a 3 μm-thick PPy film, both the CNM and the CPD cells with an 11 μm-cell gap were prepared. CNM consists of 21 wt.-% CE2, 21 wt.-% CB15 and 58 wt.-% E48 from BDH. In preparing a CPD cell, 20 wt.-% of a UV-curable resin, NOA-65 from Norland, was mixed with the CNM and the cell filled with the mixture was irradiated with UV light.

RESULTS AND DISCUSSION

Figure 1 illustrates the structure of the refractive cholesteric LCD with a black PPy electrode. The display in the planar state gave a selective reflection of incident light with the reflectance maximum at $\lambda = np$, where n is the average refractive index and p the cholesteric pitch of LC. When switched to the focal conic state, the LC layer became relatively transparent

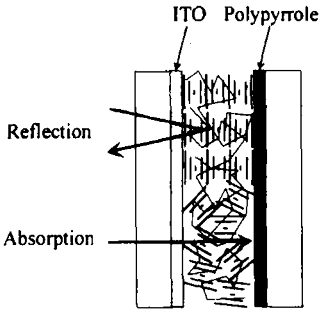

FIGURE 1 Structure of the reflective bistable cholesteric LCD fabricated with a black PPy film as the electrode and the light absorbing layer.

and the CNM cell reflected much less incident light due to the black conducting layer of PPy coated on the inner side of the rear glass plate.

The CNM cell showed the reflectance peak at 510 nm in its planar state, while the CPD cell shifted the peak to 560 nm as shown in Figures 2-a and b, respectively. The reflectance difference between the planar and the focal conic states was enhanced by the black PPy film located inside the cell wall because it absorbed the transmitted or back-scattered light more efficiently than the light absorbing layer of the conventional type[6] which was coated on the outside of the cell wall.

Reflectance was measured at 510 and 560 nm for the CNM and CPD

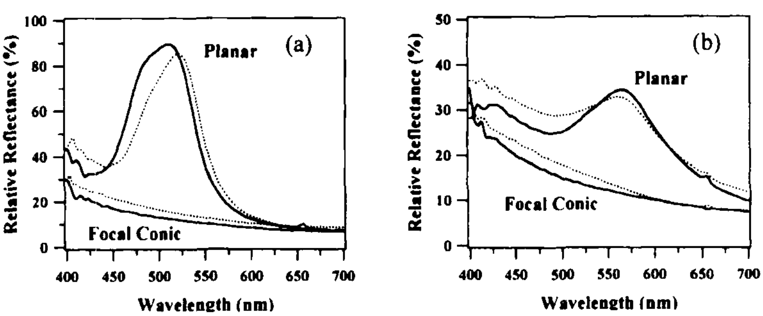

FIGURE 2 Relative reflectance spectra of (a) the CNM and (b) the CPD cells in either the planar or focal conic state. Spectra for the conventional types(dotted lines) were also shown for comparison.

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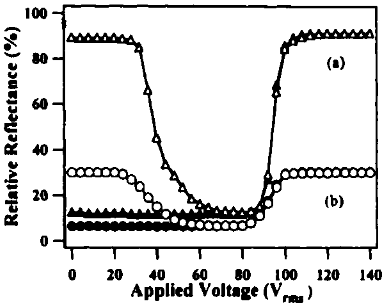

FIGURE 3 Relative reflectance as a function of applied AC voltage for the (a) CNM and (b) CPD cells initially in either the planar(open symbols) or focal conic(filled symbols) state. Reflectance at 510 and 560 nm for the CNM and CPD cells, respectively, was measured after 200 Hz-AC field was applied for 20 msec and then removed.

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cells, respectively, immediately after a 200 Hz-AC field applied for 20 msec was removed. The reflectance was plotted as a function of the applied AC voltages as shown in Figure 3. The reflectance of the CNM cell initially in the focal conic state held the same until an applied AC field of 85 V_{rms}. After an AC field higher than 100 V_{rms} was applied, switching to the planar state occurred and the reflectance increased from 13 to 89 %. The CNM cell initially in the planar state switched to the focal conic state on applying an AC field of 55~90 V_{rms} and the reflectance dropped to 13 % again. The optical contrast in reflectance between the planar and focal conic states of the CPD cell became much smaller than that of the CNM cell. However, the CPD cell maintained about 95 % of the original contrast while the CNM cell did about 60% after 6 months. This demonstrates that the polymer network stabilizes the focal conic state.

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