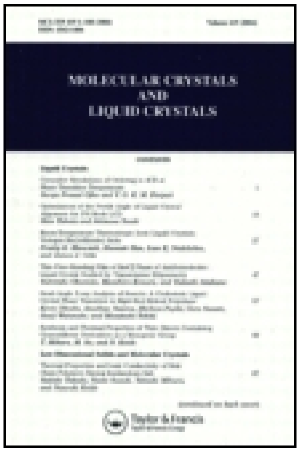

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CORRELATION OF ELECTROOPTICAL AND RAMAN CHARACTERISTICS OF POLYMER - STABILIZED CHOLESTERIC TEXTURE FILMS

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Abstract We have measured both of the electrooptical and the Raman characteristics of polymer - stabilized cholesteric texture(PSCT) films fabricated with various polymer concentrations. Some correlations between these two characteristics were found. This indicates the Raman experiment could provide us another technique to analyze the PSCT films.

INTRODUCTION

Liquid crystal - polymer dispersions have been studied intensively in recent years. These materials include standard polymer - dispersed liquid crystals (PDLC's) where the concentration of polymer in the mixture is usually more than 20% in order to confine LC's.[1-2] The other type is liquid - crystal - dispersed polymers which the polymer concentration is usually low (1-5%) for use to stabilize the LC structure in the cell, so called the polymer - stabilized cholesteric textures (PSCT).[3]

In this paper, we report the results obtained from the measurements of both the electrooptical and Raman characteristics on PSCT normal - mode films fabricated with various polymer concentrations. Some correlations between these two characteristics were found and reported.

EXPERIMENTS, RESULTS AND DISCUSSIONS

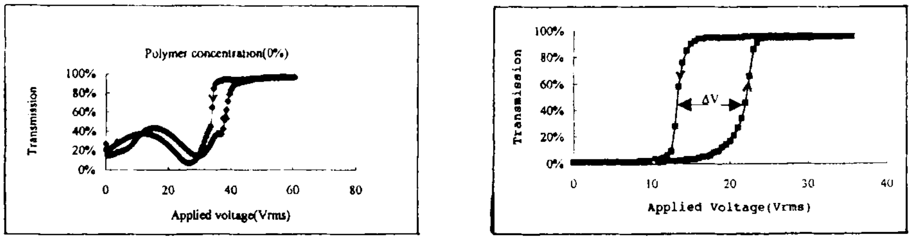
Our normal - mode PSCT cells were fabricated following the same way reported by Yang et al.[3]The experimemtal setup for measuring the films' electro - optical (E-O) characteristics was given in Ref.[4]. The amplitude of the applied square - wave voltage V_{rms} (1KHz) increases initially from 0V to the saturated voltage ~40V and then decreases back to zero in a step of 0.25V/sec.The Raman experiment was performed using the experimental setup shown in Ref.[5].

Figure 1 shows the measured E-O characteristics of a cell filled solely with liquid crystal (Fig. 1(a)) and a PSCT cell having ~2.1 wt% monomer in the mixture (Fig. 1(b)). It can be seen that the PSCT cell has a lower and stabler transmittance in the voltages below the threshold. This can be understood as follows. With the addition of monomer in the mixture, it crossed-link to become fiber-like polymer network oriented perpendicular to the cell surfaces in these PSCT cells. The formed polymer network suppresses the domains with too large a size, and therefore the smaller and the more uniform domains can be maintained. Subsequently, the scattering effect is maximized and stable. In addition, it is noted the PSCT cell also exhibits a larger hysteresis width and a lower threshold voltage. These are mainly due to the aligning effect of the polymer network.

In order to characterize the hysteresis effect, we define the hysteresis width ΔV as the difference between the voltages corresponding to the half maximum transmittance in the rising and falling curves as shown in Fig. 1(b).

Figure 2 shows the measured ΔV as a function of the dispersed polymer concentration x. ΔV is seen to keep ~3V for $x < 1.4$ wt%. This hysteresis is basically arising from the cholesteric-nematic transition. As the polymer 's concentration is above 1.4 wt%, ΔV is increasing with the polymer concentration.

Figure 3 shows the measured Raman spectrum of the PSCT film having ~2.1 wt% monomer in the mixture at field - off condition, i.e. V=0. Over the frequency range 150-3600 cm^{-1} , we found four peaks located at ~ 1182 cm^{-1}, 1285 cm^{-1}, 1606 cm^{-1}, 2226 cm^{-1}. These peaks are labeled as P_1 , P_2 , P_3 , and P_4 , respectively. Below, we report the results the studies of the P_3 line only that is the stretch mode of benzene of the E7 molecules.



(a) (b)

FIGURE 1 The measured electrooptical characteristics of (a) a cell filled with solely a cholesteric LC, (b) a PSCT cell having ~ 2.1 wt% monomer in the mixture.

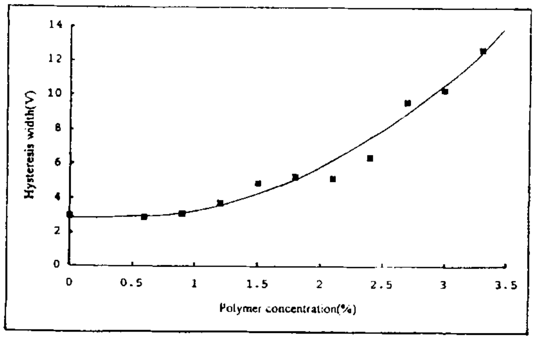


FIGURE 2 The variations of the hysteresis width ΔV of a PSCT cell with respect to the monomer's concentration in the mixtures.

The variations of the measured lineshape of P_3 as the applied voltage is rising and falling are shown in Figs. 4 and 5, respectively. It is interesting to find the lineshape of P_3 is approximately symmetrical and fitted very well with the a Lorentzian function for PSCT films with the application of voltages below threshold V_{th} . It becomes unsymmetrically at the applied voltages greater than V_{th} . In these cases, the peak was fitted well with two Lorentzian curves as shown in Fig. 6.

The cause for such a lineshape change is due to the change of the LC orientation with respect to the polarization of the excitation light. This was confirmed experimentally by measuring P_3 using a homogeneously aligning sample

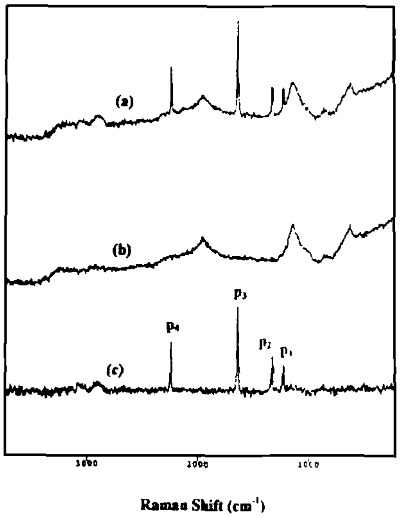


FIGURE 3 (a) The measured Raman scattering intensities of a PSCT cell having ~ 2.1 wt% monomer in the mixture at field - off condition; (b) The measure scattered intensities of an empty cell; (c) The Raman spectrum results from the substraction of Fig. 3(b) from Fig. 3(a), which is solely due to a PSCT film.

of E7. Fig. 7 shows the measured P_3 with the director axis being oriented at various angles $\theta = 0^{\circ}, 40^{\circ}, 60^{\circ}$ and 90° with respect to the polarization of the excitation light $\bar{E}_{op}$. The lineshape is approximately symmetrical at 0°, and becomes unsymmetrical as the angle deviates from 0°. However , it was found the change was not significant until the angle $\theta \sim 40^{\circ}$, but changed dramatically afterwards.

As mentioned, when the lineshape of P_3 becomes unsymmetrical, it can be fitted well with two Lorentzian curves (Fig. 6). Let's define the induced peak located at ~1613 Å to be L_2, then plot the area under L_2 versus the applied voltages. The result is shown in Fig. 8. It shows similar hysteresis effect as that shown in Fig.1(b).The hysteresis width is also increasing with the polymer concentration as Fig. 3 (not shown). Clearly, it is also due to the aligning effect of the polymer network on the liquid crystal molecules.

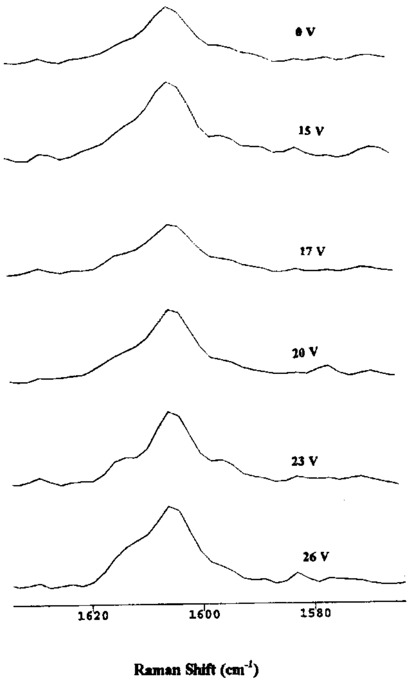


FIGURE 4 The variations of the lineshape of P_3 for the PSCT cell having ~ 2.1 wt% in the mixture as the applied voltage is rising. The applied voltage is labelled along the curve.

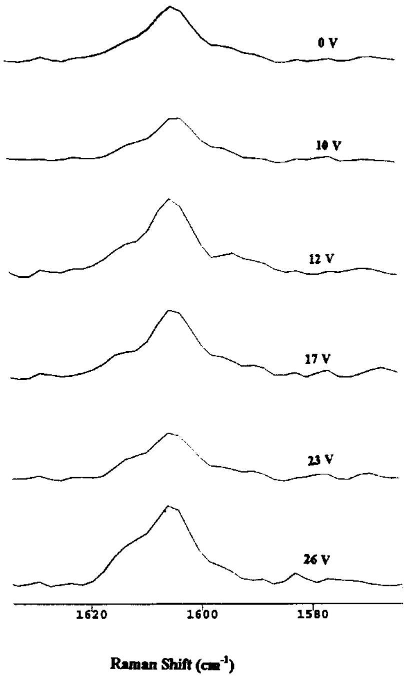


FIGURE 5 Similar to the measurements of Fig.6, but with lowing the voltage.

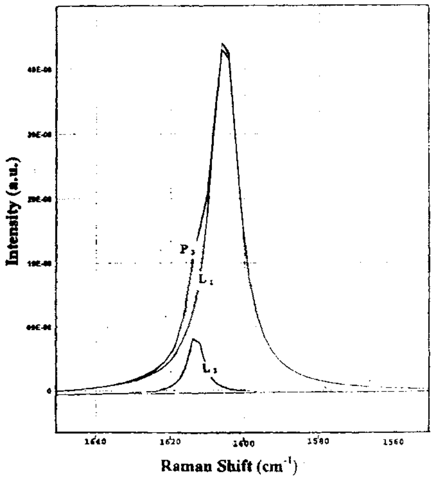


FIGURE 6 The lineshape of P_3 is fitted well with two Lorentzian curves; P_3: the measured curve, L_1: Lorentzian curve fitting #1, L_2:Lorentzian curve fitting #2.

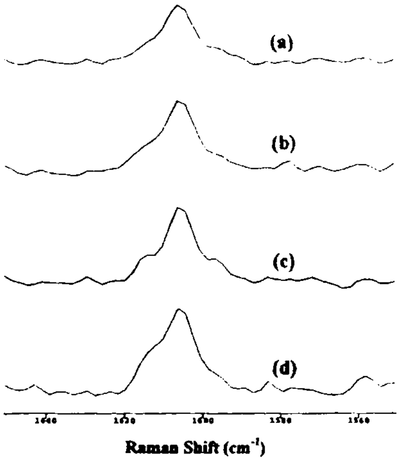


FIGURE 7 The measured Raman peak P_3 for a homogeneous aligned E7 sample with its director axis being oriented at (a) 0°, (b) 40°, (c) 60°, (d) 90° with respect to the polarization of the excitation light $\vec{E}_{op}$.

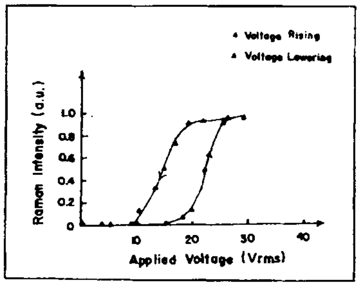


FIGURE 8 The variations of the measured L_2 intensities (the area under L_2 in Fig.6) with respect to the rising and the lowering voltages.

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