Study of the Photo-alignment Technique through the Surface Modification

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Abstract

A surface-assisted photo-control of the liquid crystal (LC) alignment has been achieved by modifying the topmost surface of the polyimide film with photo-reactive molecules. Recently, photo-alignment technique using a thin film of poly(vinyl cinnamates) have been reported. However their commercial potentiality is limited by their low thermal stability. To enhance thermal stability, we synthesized the chalcone derivatives as the photo-reactive molecules and introduced the materials on the surface-modified polyimide film.. We identified that the photo-chemical reaction of the chalcone derivatives occur in few minutes with irradiation of UV light. The photo-alignment characteristics of the modified polyimide films treated by polarized UV light and their LC cells are investigated as a function of exposure dose.

Introduction

To obtain high contrast without defect site of liquid crystals display (LCD), the uniform alignment of LCs on the alignment layer surface is need [1]. Rubbing method has been commercially used to control LC alignment. Rubbing method has some problems, such as dusts and difficulties in control strength. Several photo-alignment methods were proposed to solve the problems of conventional rubbing method. One of them is photo-dimerization or photo crosslingking[2] which forms stable chemical bonds and does not produce decomposed molecules. Cinnamic acid derivatives attached to polymers as a side chain have been investigated as photo-crosslingking polymers by many researchers [3]. Thermal instability and possible degradation by UV exposure make the commercialization of these materials difficult. We developed new technique, which includes the introduction of photo-reactive material on KOH-modified polyimide film surface and synthesizing chalcone derivatives as UV-alignment materials.

Experimental

The chalcone derivative (Fig. 1) was synthesized to use as the photo-alignment material for LC. Substitution of bromide with triethylamine generated ammonium salt, which can be introduced on to the carboxylated surface of polyimide.

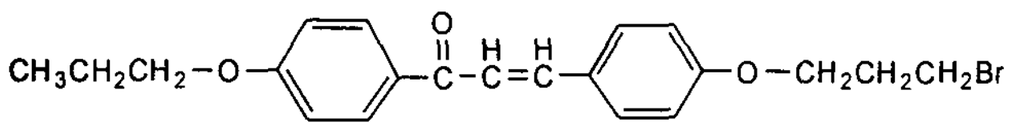
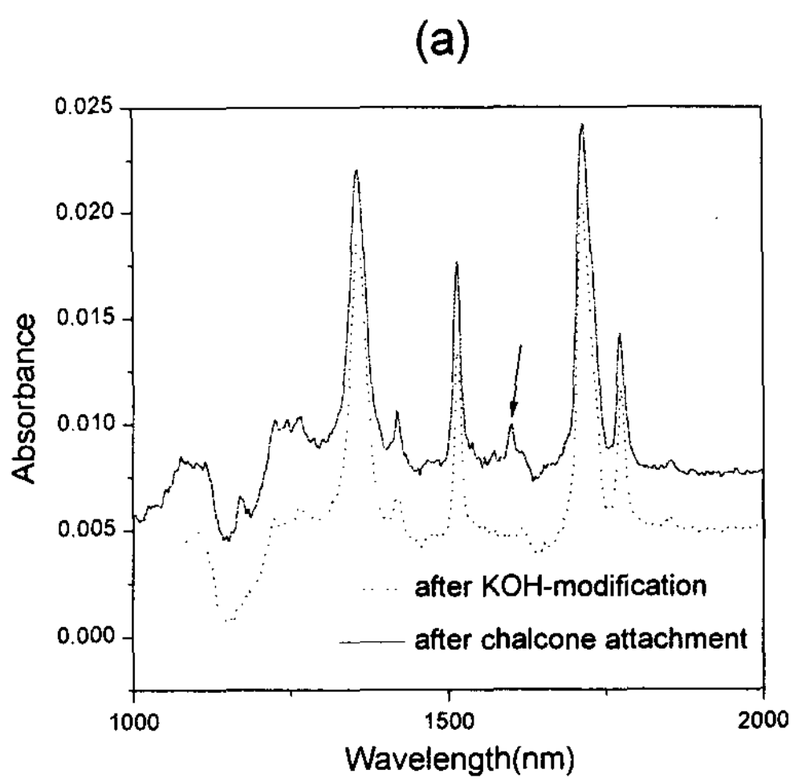


Fig.1. Structure of chalcone derivative

BPDA-PDA polyamic acid in NMP was spin-coated on to the Si wafer, quartz and glass substrates. The films were cured to form polyimide over 250°C for 1hr. Polyimide films were treated with 0.5M KOH aqueous solution at 20°C for 5min and subsquently dipped in the aminated chalcone solution for 3min. The chalcone attached polyimide films were irradiated with 4W UV lamp and characterized with IR spectroscopy and UV-visible spectroscopy. Alignment ability of LC cell was investigated by UV-visible spectroscopy.

Results and Discussion

The IR spectra of Figure. 2 show C=C stretching vibration peak near 1600 cm $^{-1}$. The UV spectrum also shows the absorption peaks of chalcone derivative at 280nm and 350nm.



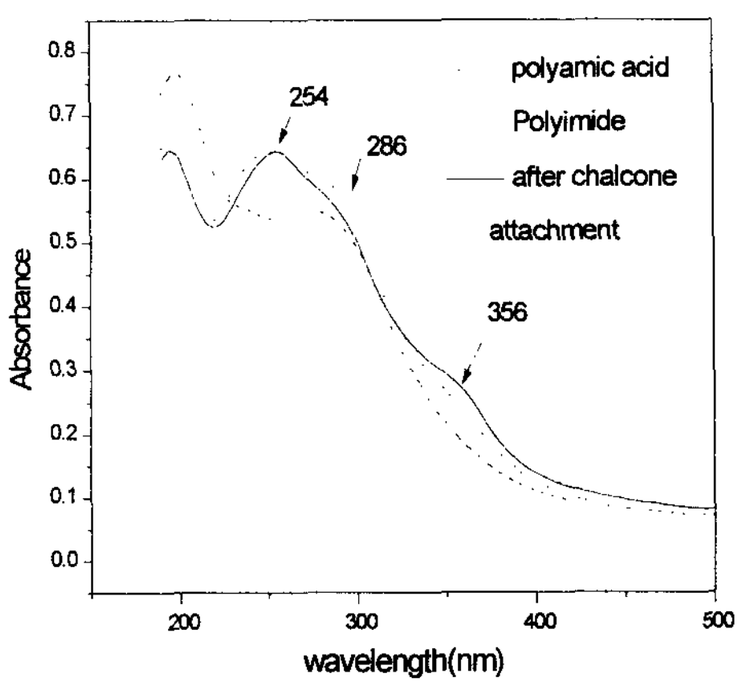


Fig.2. IR (a) and UV (b) spectra of polyimide and chalcone attached polyimide

Fig. 3 shows the gradual decrease in absorption band of chalcone derivative attached polyimide film as a function of the irradiation time. When irradiated with the 254nm-UV light, the absorbance at the near 280nm and 350nm were significantly suppressed. However, the irradiation with longer wavelength (365nm) UV light did not affect any optical characteristics of the film. This may influence on the photo stability of the LC devices.

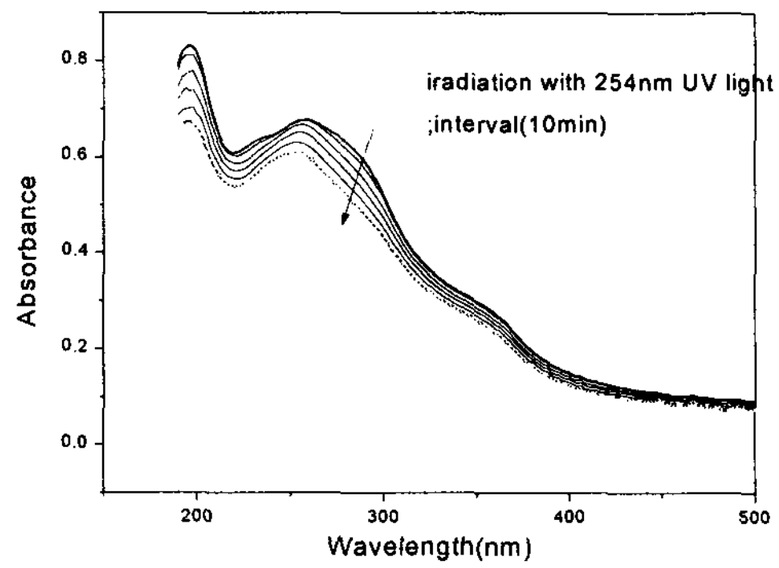


Fig.3. Absorption spectra of chalcone attached polyimide sample as a function of the irradiation time

It is very difficult to identify chalcone derivative attached on polyimide film due to low concentration chalcone moiety. The difference spectra obtained from the chalcone attached polyimide film before and after irradiation clearly show 280nm-absorption band and a shoulder at 350nm(Fig. 4). It is considered that the main change of spectra due to the dimerization of chacone.

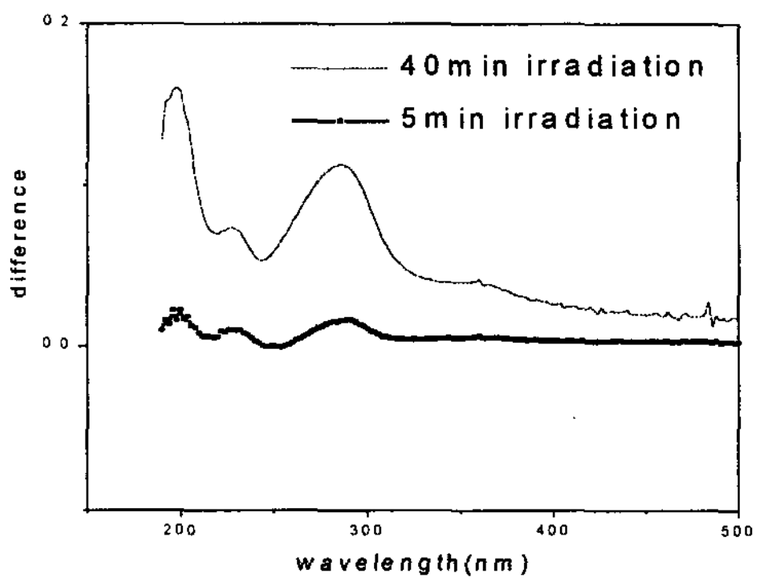


Fig.4. The subtracted spectra of the chalcone attached polyimide at a different irradiation time

Fig.5 shows UV-visible absorption peak intensity at 622nm at a function of rotation angle of the polarizer. This preliminary results show that the chalcone attached polyimide films respond sensitively to polarized UV light. It is founded that the nematic liquid crystals are perpendicular to the polarizer axis. We suppose that the terminal group after dimerization leads to perpendicular alignment of the LC molecules.

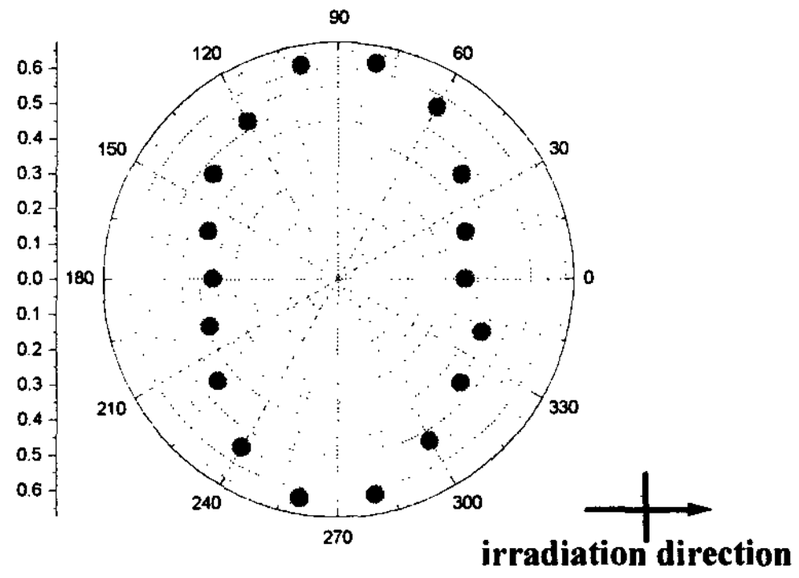


Fig.5. UV absorption of LC cell at 622nm after irradiation

Conclusion

The IR and UV results clearly show that the chalcone derivatives were introduced onto polyimide film and dimerized efficiently. We founded that the modified polyimide film treated by polarized UV light induced the alignment of liquid crystals in LC cell to the perpendicular direction.

References

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