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PHOTOINDUCED SURFACE ALIGNMENT AS AN ADVANCED TECHNOLOGY FOR DESIGN OF LIQUID CRYSTAL DISPLAYS

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1. Introduction

In the present time the photoalignment technique of liquid crystals (LCs) suggested in [1] is an alternative method that avoids the drawbacks of the mechanical surface treatment by using linearly polarized ultraviolet (uv) light to induce anisotropy of the angular distribution of molecules in a photosensitive film [2].

In order to understand the mechanism of coupling between LC molecules and surface of azo-dye film we have studied experimentally the influence of irradiation dose and azo-dye concentration (i.e. film thickness) on the anchoring properties of the photoalignment layers.

2. Experimental

- Liquid crystal: ***nematic LC 5700-000 (Merck)***
- Photoalignment layer: ***photosensitive sulfonic azo-dye SD1***
- Concentrations of SD1: ***0.5 wt % (4 nm), 1 wt % (10 nm) and 5 wt % (40 nm)***
- Solution was spin coated onto glass substrates with indium tin oxide electrodes at 3000 rpm for 30 s and dried at 100 °C.

The surfaces of the coated films were illuminated with linearly polarized UV light using a super-high-pressure Hg lamp through an interference filter at the wavelength 365 nm. The intensity of light irradiated on the film surface was 2.7 mW/cm2.

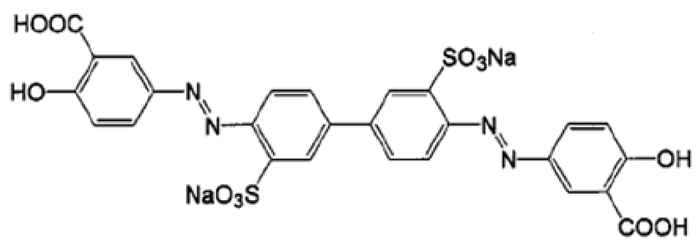

Fig. 1. *Molecular structures of the sulfuric azo-dye SD1.*

3. Results and discussion

From the measured absorption spectra the optical density components at the absorption maximum of SD1 (370 nm) were estimated for different irradiation doses and concentrations of SD1.

The absorption dichroic ratio was calculated from the formula: $R = \frac{D_{\parallel} - D_{\perp}}{D_{\parallel} + 2D_{\perp}}$

The azimuthal anchoring energy Wϕ was measured in a twisted nematic cell using the torque balance method [3] and the polar anchoring energy Wθ was measured with using the high-voltage technique [4].

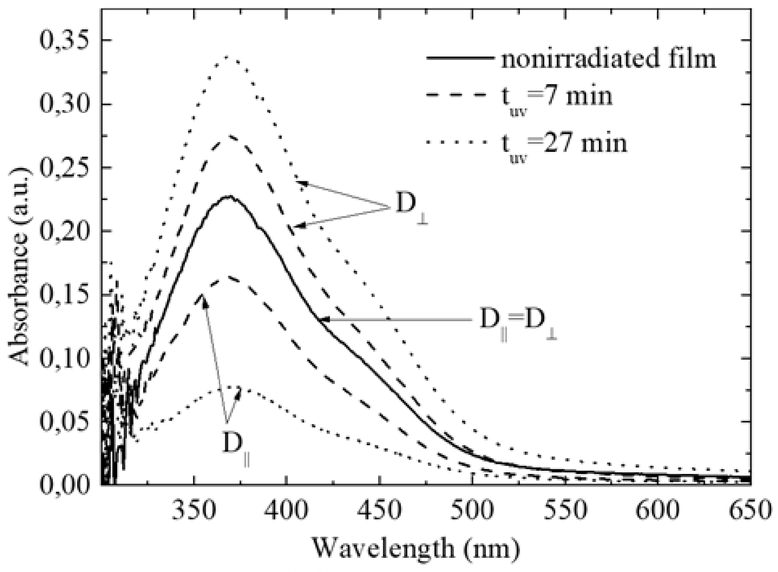

Fig. 2. *UV-visible absorption spectra of nonirradiated and irradiated SD1 films for two exposure times t_{uv}: 7 and 27 min.*

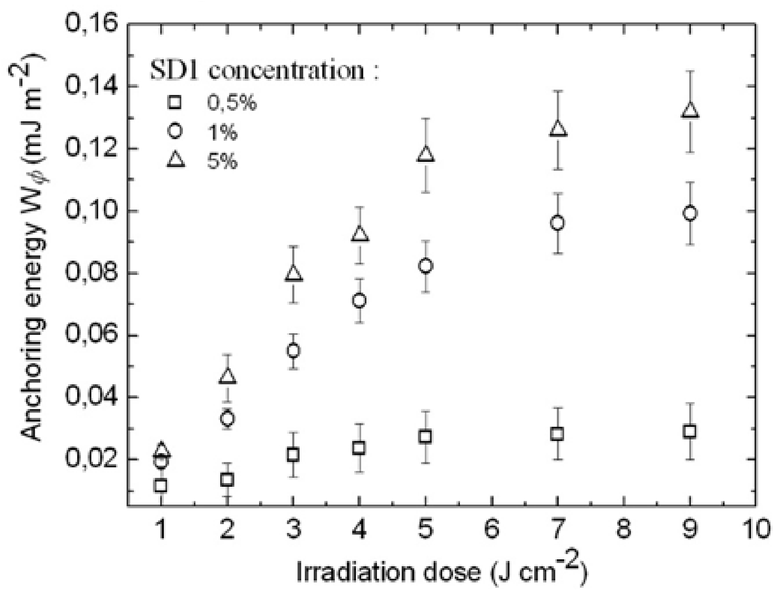

Fig. 3. *Azimuthal anchoring energy strength as a function of UV irradiation dose for different SD1 concentrations.*

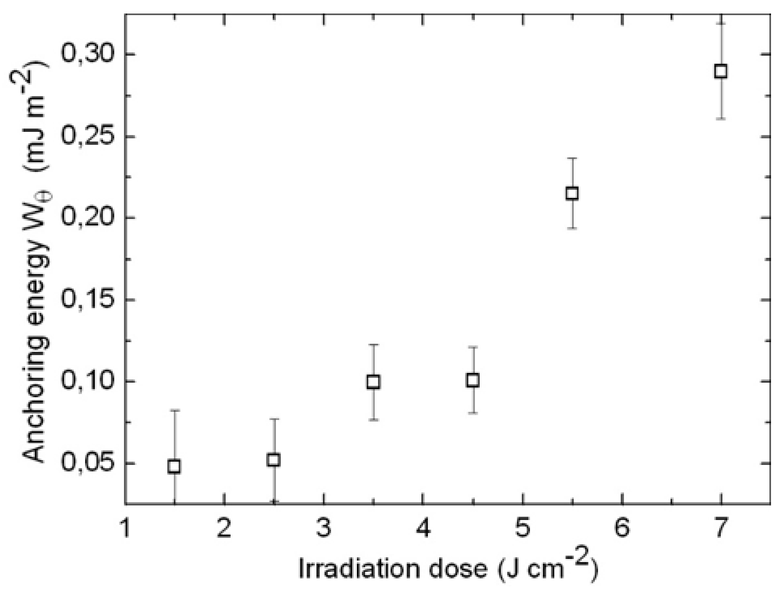

Fig. 4. *Polar anchoring energy strength as a function of UV irradiation dose for SD1 concentration 1.2 wt %.*

4. Conclusion

1. The azimuthal anchoring energy for different SD1 concentration at first grows with increasing irradiation dose then it is saturated above value of 5 J/cm2 (Fig.1).

2. The polar anchoring energy is hardly sense on the concentration of SD1, but markedly depend on irradiation dose (Fig.2).

3. The results obtained can be useful in the design of LC displays.

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Literature

1. W.G. Gibbons, P.J. Shannon, S.T. Sun, and B.J. Swetlin // Nature. 1991. Vol. 351. P. 49-50.

2. V.G. Chigrinov, V.M. Kozenkov, and H.-S. Kwok. Photoalignment of LC materials: physics and applications. Series in Display Technology. Chichester (UK): Wiley, 2008. 248 p.

3. M. O'Neill and S.M. Kelly // J. Phys. D. 2000. Vol. 33. P. R67-R84.

4. S. Furumi, M. Nakagawa, S. Morini, and K. Ichimura // Appl. Phys. Lett. 1999. Vol. 74, No. 17. P. 2438-2440.