PVA/아조염료계 편광필름의 편광효율에 따른 혼성배열 폴리비닐알코올의 분자량 효과

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Effect of Molecular weight of Atactic Poly(vinyl alcohol) (PVA) on the Polarizing Efficiency of PVA/Azo Dye Polarizer

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1. Introduction

Poly(vinyl alcohol) (PVA) obtained by the saponification of poly(vinyl ester) like poly(vinyl acetate) or poly(vinyl pivalate) is a linear semicrystalline polymer, which has been widely used as fibers for clothes and industries, films, membranes, medicines for drug delivery system, and cancer cell-killing embolic materials[1-3]. PVA fibers and films have high tensile and compressive strengths, high tensile modulus, and good abrasion resistance due to its highest crystalline lattice modulus. Especially, PVA film is a second-to-none polarizing material for liquid crystal display (LCD).

Light-polarization films or polarizers are the major components of the LCD and other liquid crystal devices. Common polarizers are based on PVA-iodine films of 50-70 ㎛ thickness. These polarizers are generally laminated on the external glass surfaces of the LCD and consist of a stack of films for the scratch protection, anti-glare, anti-reflection, phase and chromatic compensations, anisotropic absorption, etc[4-6]. However, commercial polarizing films produced from atactic PVA (a-PVA) have a serious problem of iodine desorption under humid and warm atmospheres, resulting mainly from higher affinity of a-PVA molecules to water than iodines. To overcome this shortcoming by improving water resistance of PVA, PVA film is treated instantaneously in boric acid solution to introduce crosslinking and improving water resistance by controlling molecular parameter like molecular weight. Compared with commercial a-PVA, high molecular weight (HMW) a-PVA has been known to have superior physical properties[7].

In this work, we prepared a-PVA/dye polarizing film and HMW a-PVA/dye polarizing film. Also, the polarizing efficiency (PE) and transmittance of polarizing films were investigated at the various dipping conditions, respectively.

2. Experimental

2.1. Preparations of PVA and PVA/Dye Films

A-PVA films having a thickness of about 70 ㎛ were prepared by casting a-PVAs with different number-average degrees of polymerization (P_n)s of 1700 and 4000/water in solution of optimum polymer concentrations of 7.5 and 2.5 g/dl, respectively. The homogenized solution was poured into a stainless steel dish and dried under vacuum at 40 °C for about 3 days. The azo dye (C.I. Direct Blue 71 (Figure 1)) was used for the dichroic dye. Then, PVA film was dipped into azo dye solution (0.3 and 1.0 wt.%) at predetermined temperature for 30-150 sec. The films

taken out from the solutions were rinsed with cold water to remove the solution adhered on the film surfaces and dried in a vacuum for 24 h.

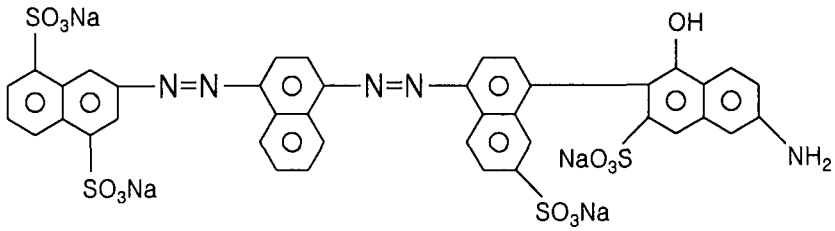

Figure 1. Doramin Light Blue BR 200% (Blue 71)

2.2. Wet Drawing of Film

The films were wet-drawn 5 times in boric acid (3 wt.%) solution at 40 °C. The stretched films were subsequently dried at 30 °C for 24 h. The film having 70 ㎛ thickness, 20 mm width, and 50 mm length was drawn at a speed of 10 mm/min. Figure 2 shows the schematic representation of wet-drawing apparatus.

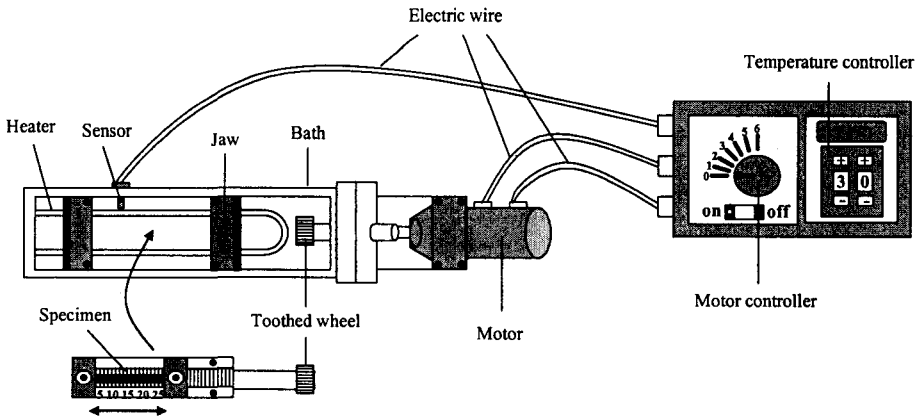

Figure 2. Schematic representation of wet-drawing apparatus.

2.3 Determination of PE

The PE (%) of a-PVA/dye film was estimated using the eq. (1).

$$PE\ (\%) = [(T_{//} - T_{\perp})/(T_{//} + T_{\perp})]^{1/2} \times 100 \quad (1)$$

where $T_{//}$ and $T_{\perp}$ are the transmittances of the film superimposed on each other parallel and perpendicular to the direction of the elongation of the film, respectively.

3. Results and Discussion

Effects of dye concentration on the transmittance and PE of a-PVA with different (P_n)s of 1700

and 4000/dye film drawn 5 times prepared by soaking in aqueous dye solutions of 0.3 wt.% and 1.0 wt.% at 30 °C are shown in Figures 3a and 3b, respectively. These films are drawn in aqueous boric acid (H_3BO_3) solution of 3 wt.% after soaking in aqueous dye solution. As increasing dipping time, PE was increased to a very high level (99.9%). Regardless of dye concentration, transmittance of a-PVA/dye film decreased with an increase of dipping time. To obtain optimum transmittance and PE values above 40% and 99%, respectively, adequate dipping time and dye concentration are essential.

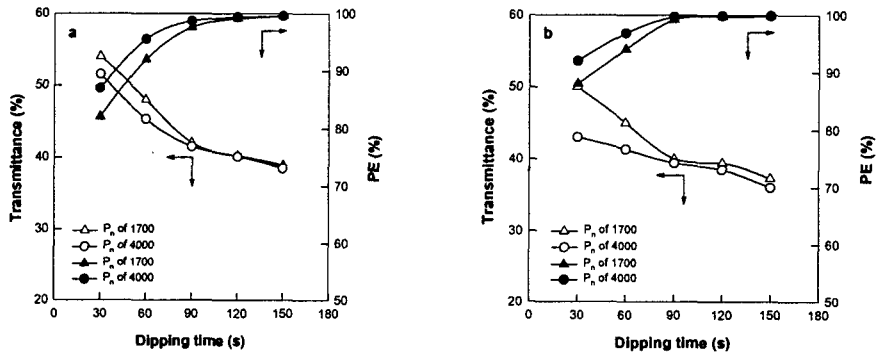

Figure. 3 Effects of dye concentration on the transmittance and PE of a-PVA with different (P_n)s of 1700 and 4000/dye film drawn 5 times prepared by soaking in aqueous dye solutions of 0.3 wt.% (a) and 1.0 wt.% (b) at 30 °C.

UV-Visible spectra of a-PVAs with P_n of 1700 (a) and 4000 (b)/dye film prepared by soaking in aqueous dye solution of 0.3 wt.% for 120 sec at 30 °C and subsequent drawing (5 times) in aqueous boric acid solution (3 wt.%) are shown in Figure 4. Most applications of polarizers demand the combination of a high PE and transmittance. Maximum transmittance and PE values of a-PVA with P_n of 1700 and 4000/dye film are 40.2%, 99.2% and 40.1%, 99.4% at 600 nm, respectively.

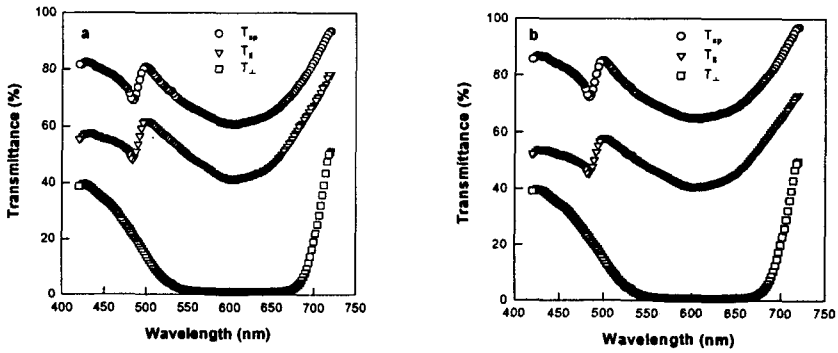

Figure 4. UV-Visible spectra of a-PVAs with P_n of 1700 (a) and 4000 (b)/dye film.

4. Conclusions

In this study, PVA with different molecular weights/dye polarizer was prepared. As increasing dipping time, PE was increased to a very high level (99.9%) and transmittance was decreased.

Regardless of dye concentration, transmittance of a-PVA/dye film decreased with an increase of dipping time. The transmittance of a-PVA/dye film dipped at dye concentration of 0.3 wt.% indicated a higher level than that of a-PVA/dye film dipped at concentration of 1.0 wt.%. Maximum transmittance and PE values of a-PVA with P_n of 1700 and 4000/dye film prepared by soaking in aqueous dye solution of 0.3 wt.% for 120 sec at 30 °C and subsequent drawing (5 times) in aqueous boric acid solution (3 wt.%) are 40.2%, 99.2% and 40.1%, 99.4% at 600 nm, respectively.

5. References

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