The Degree of Polarization of Dichroic Polarizer of Polyvinyl Alcohol-Iodine in the Region of 240–1000 mμ

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Descriptions were given of the nature and the optical properties of several kinds of sheet polarizer[1], and of the quantitative expressions of partial dichroic polarizers[2]. But most attention was merely confined to the visible light. The present communication shows the degree of polarization, extending from 240 mμ to 1000 mμ, of a dichroic polarizer which is made by stretching the sheet of polyvinyl alcohol-iodine colored in a deep blue.

PVA (abbreviation for polyvinyl alcohol) of which the degree of polymerization was about 1500 was served to make sheet. The preparation of the sheet was described in another place[3]. The iodine solution in which the PVA sheet was soaked was prepared as the aqueous solution in the following percentages: iodine (0.1–1 g. %), ammonium iodide (2.5 times as much as iodine), sodium iodide (the same as ammonium iodide) and boric acid (5 g. %). The PVA sheet soaked in the above solution was colored in a deep blue within ten or twenty seconds. The colored sheet was stretched about five times its length in the aqueous solution of 5 % boric acid keeping about 40°C. Thus the sheet polarizer was prepared. Such a sheet looks almost neutral in color when viewed in unpolarized light, but it looks a remarkably deep blue when viewed in linerly polarized light with the electric vector parallel with the stretch direction.

Now, the degree of polarization V of the light transmitted by a single polarizer is expressed in terms of the principal transmissions k_y and k_z as follows:

$$V=\frac{k_y-k_z}{k_y+k_z} \tag{1}$$

where k_y is the transmission for the incident light completely and linerly polarized when the electric vector is at right angles to the stretch direction, and similarly k_z is the corresponding transmission when the electric vector is parallel with the stretch direction. On the other hand, for the incident unpolarized light, each of the transmissions $H_{\parallel}$ and $H_{\perp}$ of two identical partial polarizers, whose corresponding directions are respectively parallel and crossed, can be associated with k_y and k_z as follows[2];

$$\begin{aligned} H_{\parallel}&=\frac{1}{2}(k_y^2+k_z^2) \\ H_{\perp}&=k_yk_z \end{aligned} \tag{2}$$

1) E. H. Land *J. Opt. Soc. Am.* **41**, 957 (1951).
2) C. D. West and R. Clark Jones, *J. Opt. Soc. Am.* **41**, 976 (1951).
3) Y. Tanizaki and N. Ando, *J. Chem. Soc. Japan, Pure Chem. Sec.* **78**, 542 (1957).

Then, in this case, the degree of polarization $V(\%)$ of the light transmitted by a single partial polarizer is also given by

$$V=\left(\frac{H_{\parallel}-H_{\perp}}{H_{\parallel}+H_{\perp}}\right)^{\frac{1}{2}}\times 100(\%) \qquad (3)$$

The Beckman DU spectrophotometer was used to measure the transmissions $H_{\parallel}$ and $H_{\perp}$ according to the procedure repotred previously[3]. One of the experimental results is shown, as a typical example, by the solid lines in Fig. 1. In

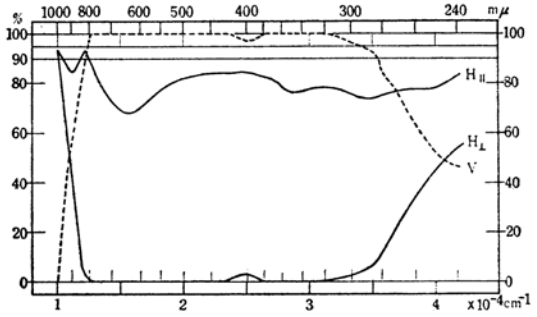

Fig. 1.

the same figure the dotted line indicates the degree of polarization, calculated from equation (3), of the light transmitted by the single sheet. The curve V shows that the degree of polarization is higher than 95 % in 295–800 mμ and is almost 100% in 320–380mμ and 420–790mμ. In case of this measurement the partially polarized incident light of the spectrophotometer (e. g., about 5 % at 500 mμ) was disregarded for the degree of polarization, and the correction for reflection at (four) surfaces of sheet polarizers had not been carried out. If these neglected values are taken into account, the V values all over the region will certainly become higher. It is interesting to notice that the pair of sheet polarizers, piled so as to cross their stretch directions, cuts off sharply the light in 250–800 mμ, as shown by the $H_{\perp}$ curve in Fig. 1.

This kind of sheet polarizer prepared under some conditions is not only of practical use[1] but also useful for some investigation[3], because this sheet has a high degree of polarization in the considerably broad region in wavelength and the sheet polarizer itself is comparatively stable. In our laboratory, more than two years have passed since the sheet polarizer was made and set in the filter hole of the spectrophotometer, but it has been kept in the same optical property as described above.

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