A PHOTOGAPHIC METHOD FOR THE MEASUREMENT OF THE PER CENT OF POLARIZATION AND SOME OF ITS APPLICATIONS.

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In many problems in luminescence the ordinary compensating methods for the measurement of the per cent of polarization are unsatisfactory because the low intensity makes direct observation difficult. It was therefore thought advisable to attempt some method which would utilize the integrating power of a photographic plate. The method

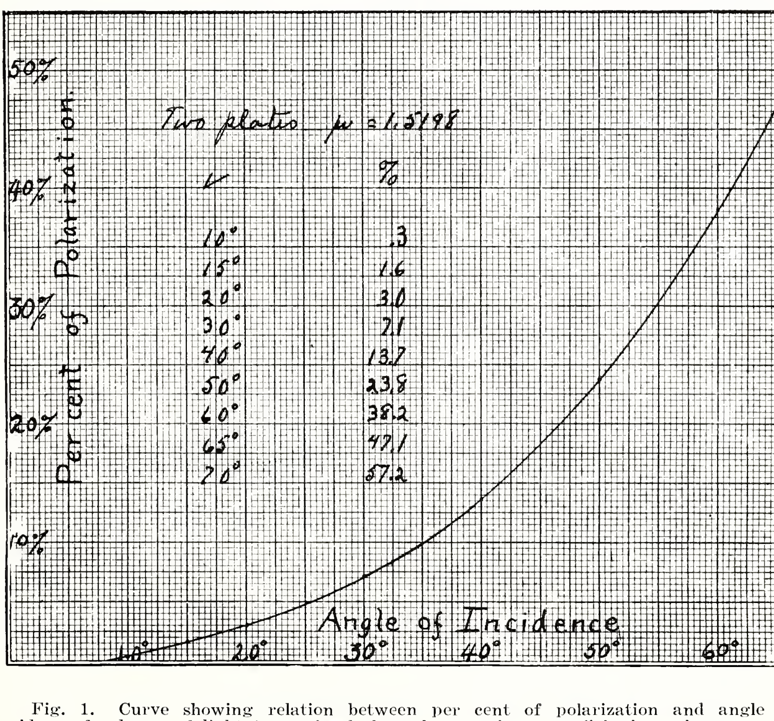

Fig. 1. Curve showing relation between per cent of polarization and angle of incidence for beam of light transmitted through two plane parallel glass plates.

finally used is a slight modification of the usual compensating plates. The index of refraction of a matched pair of plane parallel glass plates was carefully determined and then the per cent of polarization of the transmitted beam was computed for different angles of incidence. A curve was plotted using the angles of incidence as absissae and the per cent of polarization as ordinates. Figure 1 shows this relation.

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The computation of the per cent of polarization in the transmitted beam depends upon the equation for the ratio of the amplitudes of the vibration in the plane of incidence to that perpendicular to that plane as derived from the classical theory, $\frac{Dp}{Ds} = \cos(\varphi - x)$.

If the light passed through four planes as it does with two plates, this ratio is then equal to $\cos^4(\varphi - x)$. The ratios of the intensities would then be the square of this or $\cos^8(\varphi - x)$.

If then, for example, we take an angle of incidence of 20° with the index for the plates of 1.5198 we have the ratio of the intensities of the two beams equal to .942. The per cent of polarization would then be the ratio of the difference in intensity of the beams to their combined intensity or $\frac{.058}{1.942}$. This gives a computed polarization for this angle of incidence of 3 per cent.

After establishing the relation between the angle of incidence and per cent of polarization the plates were mounted on the table of a spectrometer and the scale read when they were adjusted perpendicular to the collimator. The slit was then removed from the collimator and the lens (L_1, fig. 2) adjusted so the source of light, an arc A, gave a

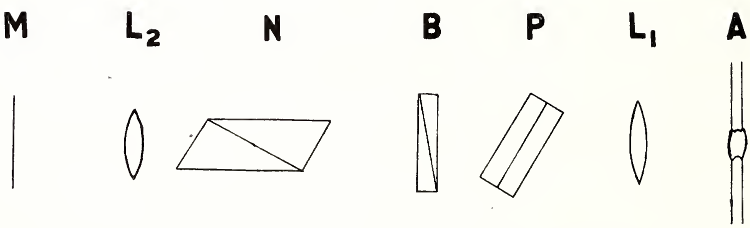

Fig. 2. Diagram of apparatus used to obtain the comparison negatives.

beam of parallel rays incident on the plates P. This beam after transmission through the plates next fell on the quartz wedges of a Babinet compensator B and an analyzing Nicol N. This when properly crossed gives a set of fringes in the plane of the wedges. A lens L_2 was used to focus these fringes on the photographic plate at M. Photographs were then made of fringe systems representing known per cents of polarization and this series of plates used as comparison plates.

The Babinet with its photographic attachments was then used for the analysis of the light under investigation. Analysis was made in some cases where the light was so weak that eighty hours' exposure was necessary.

With some care in standardizing the density of the comparison plates and the unknowns it was surprisingly easy to determine the per cent of polarization in this way to within one or two per cent. Most authors give the lower limit of the Babinet as about one per cent and direct observation on the one used checked this. The negative showing a one per cent polarization gives practically the same detail as direct vision. Figure 3 shows prints from several of these comparison plates and gives some idea of the variation of the appearance of the plates for different percentages. Much of the contrast is unavoidably lost in reprinting, so the plate is not a fair index of the possibilities of the method.

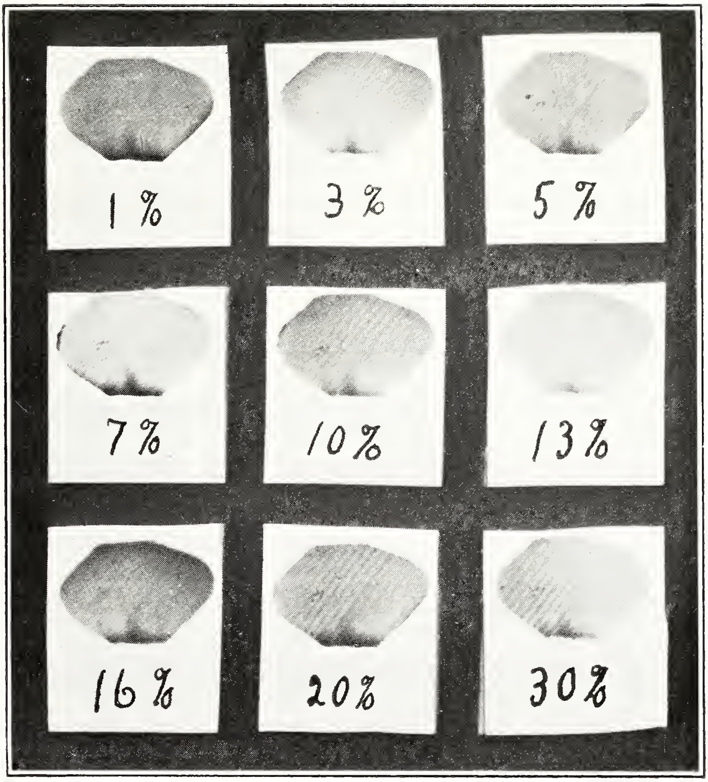

Fig. 3. Prints of comparison plates, showing variation in the appearance of plates for different percentages of polarization.

The investigations in which the author has used this method are a study of the polarization of the fluorescent light from solutions of fluorescin and rhodamine B when excited with plane polarized light. Considerable controversy had arisen as to whether the fluorescent light from such solutions was truly polarized or whether the investigators who had reported such observations were not really measuring scattered incident light. With this method a careful photographic check of the transmission bands of the double screens used could be made and a check plate was exposed with a highly scattering non-fluorescent solution for every set of screens used.

The following table gives some of the results obtained:

Fluorescin in water	below	1%– 3%
Fluorescin in water and glycerine	below	1%–20%
Fluorescin in glycerine		15%–30%
Rhodamine B in water	below	1%
Rhodamine B in alcohol	below	1%
Rhodamine B in alcohol and glycerine	below	1%– 2%
Rhodamine B in water and glycerine	below	1%– 5%
Rhodamine B in glycerine (1000 watt lamp)		3%–15%
Rhodamine B in glycerine (arc lamp)		10%
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Rhodamine B in glycerine (mercury .00005461)		35%
Rhodamine B in glycerine (mercury .00003650)		20%

Center of fluorescence band for Rhodamine B about .000058.

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Where a variation in values is indicated above, several plates were taken with different concentrations. In general, the more concentrated the dye-stuff the less the polarization. Also in the solutions of water and alcohol with glycerine, the larger the concentration of glycerine the larger the polarization.

When so marked a difference was shown in two plates from the same solution of Rhodamine B in glycerine from the exposure of one to an arc and the other to an incandescent lamp, a variation in effect due to the frequency of the incident light was suggested. First a plate was made using the light from an arc filtered through a small glass spectrograph in such a way that the solution was excited on one side of the field by about $\lambda=.000054$ and changing to about $\lambda=.00034$ on the other side of the field. Markedly clearer fringes were shown on the side illuminated by the light nearest in frequency to the fluorescent band. Light from a quartz mercury arc was then filtered through a quartz spectrograph and plates made with 5461 and the 3650 mercury lines as shown above. Work is being continued on this investigation in an attempt to find the law governing the variation of polarization with wave length of the exciting light.