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A REDETERMINATION OF THE PRINCIPAL REFLECTING POWERS OF ISOLATED SELENIUM CRYSTALS

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Some time ago, following the publication of a paper by one of my former students, Mr. C. H. Skinner,[1] I attempted to check his results by direct experiment. The paper referred to dealt with the optical constants of isolated selenium crystals. Of these constants, the reflecting power is the only one that offers itself to an easy experimental test. It must be said that the results obtained by Skinner were obtained by indirect means, and since the equations used in reducing his results to optical constants were somewhat complicated, and rested on foundations none too sure, it was important for our own satisfaction at least, to make a direct test of their accuracy. The results of my experiments[2] confirmed me in my belief that there were two principal reflecting powers to be expected; that with the incident light plane polarized with the electric vector parallel to the crystal axis, and that with the vector perpendicular to the axis. At the time of publication, however, it was felt that the results should be looked on as merely preliminary in nature on account of the difficulty I had in setting up a satisfactory spectrophotometer for the small reflecting surfaces available.

Last fall I finally succeeded in devising a form of apparatus which proved to be highly satisfactory for the work in hand. With this apparatus I made a redetermination of the two principal reflecting powers, confirming in a general way my previous results. While the present results are not entirely free from error, they are so much more consistent than the former, that I feel considerable confidence in them. The same method of procedure is now being followed in the study of tellurium crystals.

The arrangement of the apparatus is shown in elevation in figure 1. Light of the desired wave length from the slit of the monochromatic illuminator S is made parallel by lens L_1. A portion of this beam is intercepted by mirror M_1, and then made

1 Skinner, Phys. Rev., 9, p. 148, 1917.

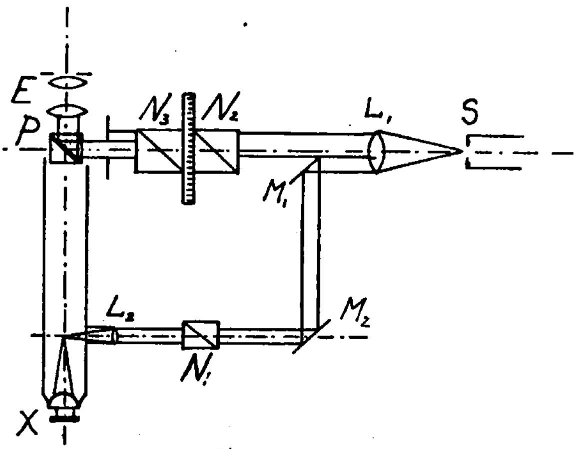

FIGURE 1.

by mirror M_2 to pass through Nicol N_1 to the opaque illuminator of the Saveur type in one of the regular metallographic microscopes of Bausch and Lomb. This plane polarized light, with the electric vector horizontal, was reflected through the objective system (usually an 8 mm. objective was employed), and fell normally upon the crystal X. In fact this is really a cone of light which falls upon the crystal, but the angle of the cone is only about 3°, and so for all practical purposes the incidence is normal. The crystal X is mounted on the stage in a special holder and can be turned without loss in centering or in maintenance of plane, so that its long axis is either parallel or perpendicular to the electric vector of the incident plane polarized light. The reflected light passes up through the tube, and forms a real image of the crystal surface on the interface of the double prism P. This image owes its intensity to the magnitude of the reflecting power of the crystal in the particular position it happens to occupy. The double prism P consists of two small right-angled prisms, one of them silvered, with the silver film cut into a grid by removing alternate narrow strips of the silver. That portion of the image passing between the strips is viewed by the eyepiece E. The upper portion of the beam from L_1 passes through the two Nicols, N_2 and N_3, illuminating the silver strips. The latter are viewed by the same eyepiece E. By adjusting the Nicol N_2 (N_3 set to make the electric vector horizontal) a match in intensity can be made for each wave length, and for each position of the crystal. With this arrangement, as far as described, only the relative reflecting powers in the two principal positions can be determined. In order to obtain the absolute reflecting powers a piece of glass,

2 Sieg, Proc. Ia. Acad. Sci., 23, p. 179, 1916.

backed with silver, is substituted for the crystal at X. The absolute reflecting power of glass backed with silver being easily found in physical tables, it becomes a simple matter to translate relative reflecting powers into absolute ones. On account of the loss in light resulting from dividing the beam, and using fairly high magnification it was not found possible to extend the results very far toward either the red or the violet end of the spectrum. Individual sets of observations were somewhat difficult to repeat with any great consistency, but by making many different settings, and using several different crystals it is felt that the mean results are correct to somewhere between 5 and 7 per cent.

The extensive original data will not be presented here. The final mean values are shown in graphical form in the curves of figure 2. The curves are largely self-explanatory. The data of Foersterling and Fréedericksz,[3] and of Pfund [4] are recorded for the

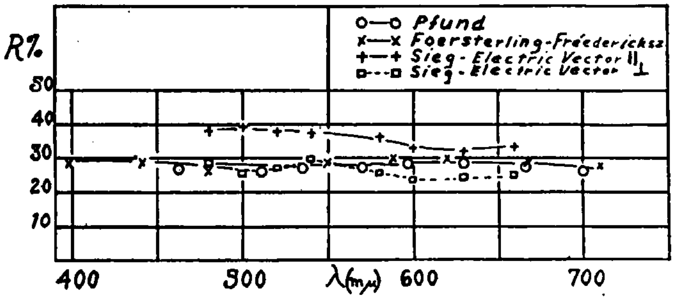

FIGURE 2.

sake of comparison of my results with the results of other observers on crystalline selenium in the form of cast, polished plates. The essential point to emphasize is that here we have double reflecting powers and that in previous work we have single reflecting powers. That former values are not exactly half way between these present double values is of no great moment. An exact mean would imply that the crystals were all lying on their sides, and haphazardly arranged. If any crystals were inclined to the reflecting surface of the plate, then the smaller reflecting power would predominate. In fact recently Grippenberg [5] has concluded that in the process of crystallization of selenium plates, most of the crystals are formed "end on" to the plane surface. This agrees well with the results shown in figure 2, as previous values are distinctly below the average positions of my results.

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[3] Foersterling and Fréedericksz, Ann. der Phys., 43, p. 1227, 1914.
[4] Pfund, Phys. Zeit., 10, p. 340, 1909.
[5] Grippenberg, Phys. Zeit., 22, p. 281, 1921.