A Note on the Photographic Measurement of the Transmission of Fluorite in the Extreme Ultraviolet

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The measurement of the transmission of a piece of colorless fluorite was made by photographic methods and the results are compared with those obtained with a photoelectric cell for the same crystalline plate. The wave-length range covered was between 1240 and 1600A.

THE transmission of a piece of colorless fluorite (1.9 mm thick) from Zelle in Baden was measured by using a vacuum spectrograph of the type described by T. Lyman in his book, *Spectroscopy of the Extreme Ultraviolet.* The light from a hydrogen discharge tube passed through a 0.15 mm slit, fell on a 15,000 line to the inch glass grating of one meter radius, and was recorded by a Cramer Contrast plate sensitized with a ten percent solution of Cenco Pump Oil, 11,021-C, in petroleum ether. A windlass turned by a stopcock served to move a holder carrying the fluorite in and out of the path of light without disturbing the discharge. When in position the fluorite plate was about 1.5 cm in front of the slit and about twice that distance from the end of the capillary which served as the source.

Preliminary tests showed that moderately high pressures and current densities in the discharge gave the most constant intensity and that under these conditions the variations from this part of the apparatus were quite masked by the irregularities due to the inhomogeneities in the emulsion of the plate. These inhomogeneities gave rise to discrepancies of six or seven percent between individual readings in spite of such precautions as soaking the plate in distilled water before developing, brush development and slow drying.

It was also found that the amount of scattered light in the spectrograph was almost negligible. To test this point plates of fluorite, quartz and glass were used to cut out the waves below their limits of transmission and exposures of over ten times the longest used in the experiment failed to give more than a possible trace of darkening in the regions where the light was absorbed by these filters. This showed that there was practically no light of long wave-length scattered onto the short wave end of the plate. Since there is no simple way of cutting out the longer wave-lengths while allowing the shorter ones to pass into the spectrograph, it was assumed that the short wave-length light was not scattered into the long wave regions in large amounts.

The formula for the transmission T of a substance at any given wave-length is

$$T = I_1/I_2 = (t_2/t_1)^p,$$

where I_1 and t_1 are the intensity and time of exposure through the substance, and I_2 and t_2 those with the material removed from the path of light, and where either or both values of I and t are adjusted to give the same blackening of the plate for the two exposures. It is customary to keep the intensity of the source constant and to vary the time of exposure to meet these conditions.

Since this method necessitates a knowledge of the value of the exponent, p, the relationship between the intensity and time to produce a given photographic density was studied at the fluorescent wave-length of the oil, 3400–4400A, as suggested in the report of Harrison and Leighton.[1] Pieces of exposed photographic plate which had been calibrated for λ4385 by the Bureau of Standards were used to cut down the intensity of light from a mercury arc by known amounts, and comparison of the density-log exposure curves obtained by holding the time constant in

[1] G. R. Harrison and P. A. Leighton, J. O. S. A. **20**, 313 (1930).

one case and the intensity in the other showed that the value of p was 0.96 ± 0.01. Although the wave-length used for this computation was about 500A longer than that of the maximum of the oil fluorescence, the correction seems valid since wire screens as described by G. R. Harrison[2] also gave this value for λλ4046, 3650, and for λ2537 if the plate was sensitized with the oil solution. The results obtained with the wire screens were not as accurate as the value given above, however, as their transmission was not as closely determined.

The final results are embodied in Fig. 1 where the accuracy is of the order of magnitude of three percent. For the purposes of comparison the transmission obtained by W. M. Powell with a photoelectric cell for the same piece of fluorite is given.

It appears that the photographic method gives slightly higher values, but this discrepancy is small enough to be accounted for by the fact that in the measurements with the photoelectric cell the crystal was placed approximately at the focus of the grating whereas in the photographic measurements it was between the source and the slit. Under the latter circumstances, since the source more than filled the grating, slight imperfections in the polish of the fluorite tended to scatter additional light into the cone subtended by the grating at the slit.

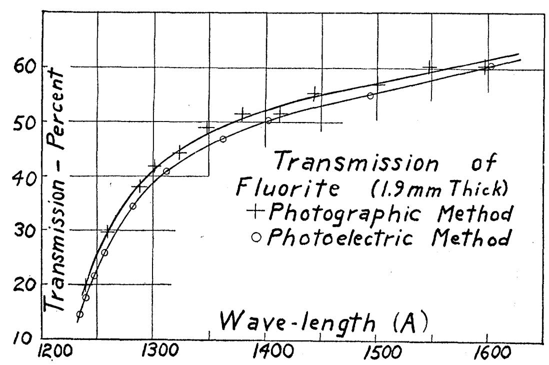

FIG. 1.

In conclusion the author wishes to express his gratitude to Professor T. Lyman for his kindness in suggesting the problem and his continued interest in its progress.

[2] G. R. Harrison, J. O. S. A. **18**, 492 (1929).