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Polarization produced by grazing-incidence monochromators*

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DISCLAIMER

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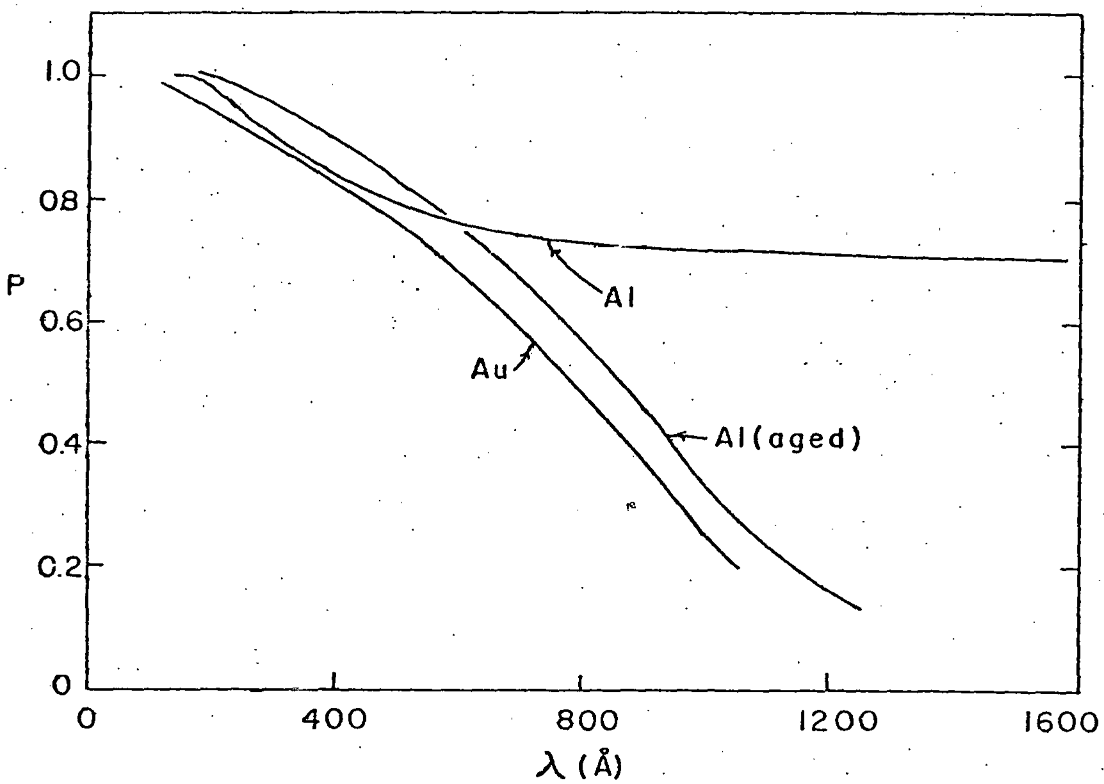
The grating in a monochromator introduces some polarization into the optical beam, the amount depending on the geometry of the system and on the type of grating. A knowledge of this polarization is important, whether the monochromator is used for the spectral analysis of an experimental source of electromagnetic radiation or to produce monochromatic radiation for optical or photoelectric yield experiments. Since it cannot, at this time, be calculated theoretically it is necessary to measure directly the polarization introduced by the grating.

We have previously measured the polarization introduced by various gratings used in the Seya-Namioka geometry.(1) It is of interest to extend these observations to a grazing-incidence geometry which is employed in grazing-incidence monochromators to obtain spectra to smaller wavelengths than is possible with a Seya-Namioka monochromator.

In the measurements reported here the monochromator was a McPherson Model 247. This is a 2.2m grazing-incidence (82° from the grating normal) scanning monochromator equipped with a concave replica diffraction grating. A condensed spark discharge source was located at the moveable slit while a calibrated triple reflection polarizer, employed as the analyzer, was attached to the stationary slit. The construction, evaluation, and calibration of our triple reflection polarizers has been described previously.(2) Light transmitted through the analyzer was detected by a photomultiplier tube coated with sodium salicylate. The polarization, P, introduced by the grating is given by $P = R_p/R_s$ where R_p and R_s are the reflectances from the grating of parallel and perpendicularly polarized light. Values of P were obtained, as described previously,[1,2] from $P = (I_{\perp} - I_{11}\rho)/(I_{11} - I_{\perp}\rho)$ where I_{11} is the intensity measured with the analyzer and grating having a common plane of incidence, $I_{\perp}$ is the intensity with the analyzer rotated through 90°, and ρ is the polarization ratio for the analyzer. Since $\rho \ll 1$ for our triple reflection analyzer (70° - 50° - 70°) over the wavelength range of the measurements reported here, $P \simeq I_{\perp}/I_{11}$.



The values obtained for P over the spectral range from 200 to 1600 Å are shown in the figure. The data shown for gold represent values obtained on three separate gratings overcoated with gold. Each of these gratings had a blaze angle of 1°30' and 600 lines/mm. The data for the aluminized gratings were obtained on two separate gratings each with a blaze angle of 2°4' and 300 lines/mm. The polarization for the gold covered gratings did not change appreciably during several years of use whereas that for one of the aluminized gratings was drastically altered, presumably due to contamination by pump oil.[3,4] The change shown was found after about 2 years use in our monochromator.

A single observation[5] is available for comparison with our results. An aluminized replica grating gave a polarization P of 0.61 ± 0.03, according to our definition, for an angle of incidence of 84°35' and at a wavelength of 584 Å. The polarization shown in the figure as a function of wavelength can be assumed to apply for an angle of incidence of 82° on the grating although in our measurements the fixed angle of 82° was actually between the diffracted beam and the normal to the grating. This can be seen by evoking Fermat's Principle and the reversibility of light rays for each wavelength individually.

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