may lie in the presence of traces of nitrogenous bases in the phosphite used at that time.

The esters, whose constants are shown in Table I, were obtained in yields of 84% or better. The products were finally purified by distillation through a 15-plate ring-packed fractionating column.

Determination of Viscosity.—The determinations were made conventionally in an Ostwald viscosimeter at 32 and 52°, the results being correlated with water standard.

Determination of Dielectric Constants.—The determinations were made at 32° by means of the Sargent Oscillometer, Model V, which was calibrated with carefully purified substances, whose dielectric constants had been accurately established earlier.[5] The dielectric constants of the phosphonates fell within the substantially linear portion of the calibration curve of the instrument. Thus it was possible to determine the relative values of the dielectric constants of any two substances to four, or even five, significant figures from the readings of the instrument. However, the actual accuracy of the determinations was obviously limited by the accuracy of the values taken as standards, a situation that has been common in such determinations.

Calculation of the Dipole Moments.—The dipole moments were calculated by the Böttcher equation and the results are shown in Table I. The values of the dipole moments are estimated to be accurate within 0.02 *D*.

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(5) E. Treiber, J. Schurz and H. Koren, *Monatsh.*, **82**, 32 (1951).

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The Anisotropic Rate of Photographic Development of Single Crystals of Silver Chloride[1,2]

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The purpose of this communication is to describe some preliminary experiments which show that the rate of photographic development of silver chloride is dependent upon the crystal face exposed at the surface.

Large single crystals of silver chloride[3] were machined in the form of spheres, $^5/_8''$ in diameter, with a small shaft for handling.[4] These spheres were etched to a depth of approximately 0.01″ by agitating slowly in 1% sodium cyanide solution; X-ray photographs taken at grazing incidence and by back reflection indicated that the strains introduced by the machining operation were removed by this etching. Smooth and strain-free surfaces were obtained by rotating the crystal and lightly pressing against it a strip of wool flannel moistened with 1% sodium cyanide solution. The surfaces so obtained had the microscopic and macroscopic appearance of plate glass.

The polished crystal was washed thoroughly in water and allowed to dry. After additional exposure to artificial light at ordinary room lighting conditions, the crystal was immersed in a photographic developer such as Ansco Finex-L maintained at 5–7°. The crystal faces making small angles with the (111) plane rapidly became covered with minute grains of silver while the (100) face and the faces making small angles with the (100) plane remained free of silver for much longer periods of time. The (110) faces and surrounding area had an intermediate activity. The relative order of activity of the faces was the same in Eastman developers Dektol and DK-50. When a heavy deposit of silver was formed and the crystal was immersed in nitric acid, the silver was removed most rapidly from the (100) faces and surrounding areas.

X-Ray analysis at grazing incidence of the silver deposits indicated that on the same crystal the degree of preferred orientation of the deposit on the (100) face was greater than that of the deposit on the (111) face. The electron microscope observations made by Keith and Mitchell relative to the formation of filamentous silver in some cases and the formation of geometric figures in other cases were confirmed in this study.

It is not known at the present stage of progress whether the results reported herein represent differences in the rate of development of the latent image or simply differences in the fogging behavior of the crystal faces. An answer to this problem is being sought. Consideration will also be given in future studies to an analysis of the role of trace impurities such as silver oxide and silica on the results.

Additional experiments have indicated that the rate of etching of silver chloride crystals in acid fixing solution is also dependent on the crystal face exposed at the surface. Experimental work on the photographically important properties of silver chloride crystals is being continued.

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(1) This research was conducted under Contract No. AF 33(616)-323 with the United States Air Force, the sponsoring agency being the Aeronautical Research Laboratory of the Wright Air Development Center, Air Research and Development Command.

(2) When this manuscript was first submitted for publication, the reviewer suggested that we await the publication of the article by H. D. Keith and J. W. Mitchell, *Phil. Mag.*, **44**, 877 (1953), which describes a very extensive study of the formation of free silver on single crystals of silver bromide. Resubmission of this manuscript was postponed until copies of the article could be obtained. Of particular pertinence to the experiments reported herein is the statement by Keith and Mitchell: "Under comparable conditions, the surface density of reduction centers is usually greater on (111) than on (100) surfaces and the rate of reduction at individual centers appears higher."

(3) The crystal ingots were purchased from the Harshaw Chemical Co., Cleveland, Ohio. See H. C. Kremers, *J. Opt. Soc. Am.*, **37**, 337 (1947).

(4) See H. Leidheiser, Jr., and A. T. Gwathmey, *Trans. Electrochem. Soc.*, **91**, 97 (1947), for a description of the single crystal method of study.

Relationships between the Absorption Spectra of the 8-Quinolinol Chelates of the Group IIIb Metals and the Acidic Species of 8-Quinolinol

BY THERALD MOELLER AND FRED L. PUNDSACK

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In the course of investigations of the 8-quinolinol and 5,7-dihalo-8-quinolinol chelates of the Group IIIb metals,[1,2] marked similarities between the absorption spectra of solutions of these compounds in "neutral" non-aqueous solvents and the spectra of acidic aqueous solutions of the reagents were noted.[2] Although the absorption spectra of acidic,

(1) T. Moeller and A. J. Cohen, THIS JOURNAL, **72**, 3546 (1950).

(2) F. L. Pundsack, Doctoral Dissertation, University of Illinois (1952).