For X-rays (flat sample),

$$I = \frac{1+\cos^2 2\theta}{2\sin\theta\sin 2\theta} j|F|^2 .$$

For neutrons (cylindrical sample),

$$I = \frac{j|F|^2}{\sin\theta\sin 2\theta} .$$

The X-ray atom form factor for palladium was obtained by averaging the Pauling–Sherman (1932) values with those of Thomas–Fermi (*Internationale Tabellen*, 1935), while for oxygen the scattering factor based on Hartree's model was used. The neutron scattering amplitudes taken were $0{\cdot}58\times10^{-12}$ cm. for oxygen and $0{\cdot}63\times10^{-12}$ cm. for palladium, as determined by Shull & Wollan (1951). The absorption correction was a constant factor in the X-ray case and negligible for the neutron experiment. The observed intensities were found by summing the counts recorded on the paper tape for a given peak and subtracting the background. The neutron data were corrected for the effect of the sample holder, which was made of thin aluminum. Its scattering is shown in Fig. 1 by a thin line. The observed data were brought to an absolute scale by matching the values for the peak due to the (002) and (101) reflections.

The agreement between observed and calculated values is satisfactory, allowing for the large background observed which is probably caused by small particle size and by amorphous material present. The tendency of the observed intensity I_o to be low at large scattering angles is doubtless due to a temperature effect. The poor agreement for the neutron reflections (214) and (302) is probably due to the background being estimated too high in this neighborhood.

The neutron pattern contains four peaks due to oxygen scattering alone: (100), (102), and the unresolved peaks (104)+(212) and (214)+(302). For the first three of these peaks the observed intensity is some 25% too large (the last one being unreliable as just discussed). This may be an indication that the scattering amplitude used for palladium was perhaps too large (the peak utilized to establish the scale factor for the observed values being essentially due to palladium scattering) or that for oxygen too small, the latter being less probable. We may remark that this discrepancy does not depend on the exact value of the parameter z.

This work was performed at the Oak Ridge National Laboratory under the auspices of the Atomic Energy Commission. Our thanks are due to Mr B. S. Borie for the use of a Norelco High-Angle Spectrometer. One of us (J. W.) gratefully acknowledges the hospitality of the Oak Ridge National Laboratory for the summer 1951.

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Short Communications

Contributions intended for publication under this heading should be expressly so marked; they should not exceed about 500 *words; they should be forwarded in the usual way to the appropriate Co-editor; they will be published as speedily as possible; and proofs will not generally be submitted to authors. Publication will be quicker if the contributions are without illustrations.*

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A technique for testing the piezoelectric properties of crystals.

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Bergmann (1935) examined piezoelectric substances by subjecting them to a periodic pressure at audio-frequency and measuring the charge produced. We likewise impress a periodic pressure by means of a vibrator coupled with an oscillator circuit (1,000 c./sec.) but the charge generated, instead of being measured directly, is led through the vibrator to a cathode-ray oscillograph after appropriate amplification. The abscissa of the oscillograph is synchronized with the oscillator circuit. This device renders piezoelectricity visible and provides a very convenient means for testing the piezoelectric properties of crystals.

A small slip of crystal set upon a flat electrode is pressed by the needle electrode of the vibrator which is capable of a fine vertical movement for adjustment. Best results are obtained by inserting sheets of insulating paper between the crystal to be tested and the electrodes.

A feature of the device is that we can not only detect very feeble piezoelectricity but also directly witness the polarity of the phenomenon. The polarity may be deduced by comparing the oscillograms obtained by pressing the crystal first on one side and then on the opposite side. We see, for example, that a phase shift of just 180° takes place in the oscillograms of tourmaline pressed in this way (Fig. 1(*a*), (*b*)). The polarity is further evidenced by the test as follows: We cut the specimen into two parts and exert the pressure on them, superimposing them so that first the same and then the different sides come into contact. Whereas with the latter arrangement we obtain an oscillogram (Fig. 1(*d*)) identical with one of the single slips, with the former we observe that the charge has vanished, the two opposing charges being compensated (Fig. 1(*c*)). This test is especially useful when the charge developed is very small and we cannot tell with certainty that it actually arises from piezoelectricity. We have determined thus that harmotome, $Ba_2Si_{12}Al_4O_{32}.12H_2O$, is definitely, though very weakly, piezoelectric.

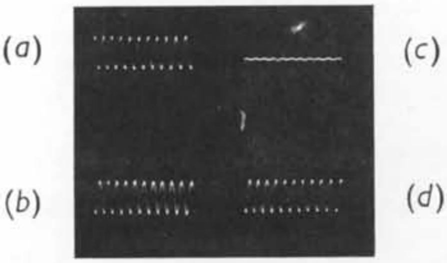

Fig. 1. Oscillograms of tourmaline (*a*) on a face (00.1); (*b*) on the face opposite to (*a*); (*c*) two slips (00.1) superimposed, the same sides of (00.1) being in contact; (*d*) two slips (00.1) superimposed, the different sides of (00.1) being in contact.

The method can be used on any tiny crystal fragment to which the pressure head (needle) of the vibrator can be applied. (This may eventually be manipulated under a microscope.) Usually crystal fragments are embedded in resin or other suitable matrix and a slip is made so that two parallel faces are cut or ground from a single fragment.

We have worked also with Cady's and Giebe & Scheibe's 'click' phenomena (Cady, 1922; see also Cady, 1946, p. 231; Giebe & Scheibe, 1925) displayed visually.* The test described above has, however, proved to be much more convenient and satisfactory.

The writer wishes to express his gratitude to Prof. Ito, who has given him guidance and encouragement throughout the present work.

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* Such a device has been developed at Prof. Hägg's laboratory in Uppsala (private communication from Prof. Ito).

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Unit cell and space group of papaverine, papaverine chlorhydrate and papaverine bromhydrate.

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1. Goniometric measurements

Papaverine or 6:7-dimethoxy-1-[3′:4′-dimethoxy-benzyl] isoquinoline ($C_{20}H_{21}O_4N$) is an alkaloid of the isoquinoline group (*Beilsteins Handbuch*, 1935). Suitable crystals for examination were obtained by slow evaporation of a solution in alcohol and water.

Some information concerning crystallographic data of the three substances cited above is to be found in Groth (1906–19); no further descriptions were found in the literature. Results of goniometric measurement are listed in the following tables.

(*a*) *Papaverine*

Needle-shaped crystals, orthorhombic system, class 222.

Forms	φ	ϱ
110	72° 18′	90° 00′
011	0° 00′	23° 11′
100	90° 00′	90° 00′
120	57° 33′	90° 00′
010	0° 00′	90° 00′
112	72° 18′	34° 45′

Forms in order of development: 110, 011, 100, 120, 010, 112.

$$a:b:c = 0{\cdot}3267:1:0{\cdot}4252\ .$$

Barker angles (Barker, 1930; Terpstra, 1946):

$$\underline{c}r = 56°\ 49', \ am = 33°\ 27', \ bq = 32°\ 27'.$$

The axial ratios, derived from the X-ray results, are:

$$a:b:c = 0{\cdot}3175:1:0{\cdot}2122.$$

The goniometric and X-ray settings are different. Transformation determinants for Groth's (G), Barker's (B) and the röntgenographic (R) settings are:

$R \rightarrow B$ 002/200/010 $R \rightarrow G$ 100/010/002
$B \rightarrow R$ 010/002/100 $G \rightarrow R$ 200/020/001
$B \rightarrow G$ 010/002/200
$G \rightarrow B$ 001/200/010

(*b*) *Papaverine chlorhydrate*

Prismatic crystals, monoclinic system, class $2/m$.