A vacuum-evaporated film of TlCl about 300A thick, deposited on a thin Formvar or collodion substrate was found to provide a satisfactory standard material. A typical transmission electron diffraction pattern is shown in Fig. 1. The angular half-width of

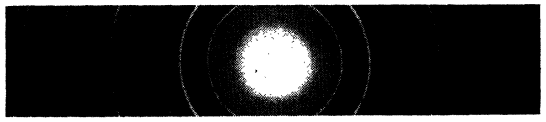

FIG. 1. A typical electron diffraction pattern of an evaporated TlCl film.

the rings (neglecting those which are overexposed) is about 3×10^{-4} radian, and this is thought to be entirely due to an instrumental factor and to the finite sizes of the diffracting crystals. The diameters of these rings can be measured readily with an accuracy of one part in 5000 by means of an optical comparator. No change has been detected in such a specimen left exposed to the air for a number of weeks.

The value which we have taken for the lattice constant of TlCl is the prevision x-ray value given by Jevins and Karlsons.[4] This value was determined assuming the wave-length of the Cu $K\alpha_1$-radiation to be 1.5374A. The lattice constant of TlCl is then 3.834A at 20°C.

We have also found MgO smoke to be useful as a secondary standard. This pattern has the defect that only two recorded rings are sufficiently sharp to allow precise measurement. The specimens were prepared by holding a Formvar-covered wire mesh about 10 in. above a short strip of burning magnesium ribbon. It was found that the lattice constant of MgO smoke did not vary from specimen to specimen. In terms of the TlCl standard mentioned above we found the lattice constant of MgO smoke to be 4.202A. This value is in agreement with the best x-ray determinations for MgO powder.

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Pulses in Argon Counters

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THE building-up of the discharge in argon counters is due to photons, as pointed out by several authors.[1] The photons generated near the wire during the initial avalanche cause the cathode or the gas to send out a number of photo-electrons which, as soon as they get near the wire, build up a new avalanche, and so on.

No definite results have been obtained from experimental work recently carried out for the purpose of discriminating between the process on the cathode and the photo-ionization in the gas, as both processes seem to lead to results which are quantitatively possible.[2]

Here we give a few experimental observations on this subject.

We have studied α- and β-particle pulses in cylindrical counters of the usual type, filled with argon (previously purified with hot calcium) operating in the proportional and Geiger zones. The brass cathodes range from 60 to 90 mm in diameter; the tungsten wires are 0.2 mm in diameter, and the argon pressure employed ranges from 15 to 100 cm Hg.

A thin layer of uranium has been placed inside the counter.

The circuit consists of a cathode follower, an amplifier mod. 100 (with a rise time of 0.6 μsec.) and a synchroscope-delay line-oscillograph system to observe and photograph the pulses. Different time constants have been employed in the amplification chain and sometimes directly on the counter, in order to differentiate the pulses in a suitable way.

Figure 1 shows the multiplication curves obtained with one of the counters for α- and β-particle pulses, and with two different time constants. Figure 2 shows the pulse forms for increasing voltages.

The interpretation of the curves and of the pulse shapes is as follows. $N(V)$ being the multiplication factor at voltage V due to the ionization process by electron collision (Townsend α-process), and A_0 the number of ion pairs generated by a primary ionizing particle, the first avalanche built up by this particle will contain $Q_0=NA_0$ electrons.

In the multiplication process photons are produced also; if f is the number of photo-electrons extracted from the cathode for each electron of the primary avalanche, the number of electrons extracted from the cathode and which reach the wire will be NA_0f. Here f depends on the nature of the gas, its pressure, the photoelectric efficiency of the cathode for the photons involved, the average solid angle under which the cathode can be seen from the wire, and the wire-to-cathode distance.

After a transit time τ, these photo-electrons reach the high field region in the neighborhood of the wire and are multiplied N times, producing an avalanche containing $Q_1=fN^2A_0$ electrons, *viz.* $Q_1=fNQ_0$.

The following avalanches will be subject to the formula $Q_k=(fN)^kQ_0$.

The foregoing holds good provided $fN<1$, as in this case the convergence of the pulse succession is ensured, and when it is possible to disregard the decrease of N produced by the positive ions which, after a few transit times τ, are still very close to the wire. The succession of photo-electronic pulses originating from every α- or β-particle has been observed by the oscilloscope,

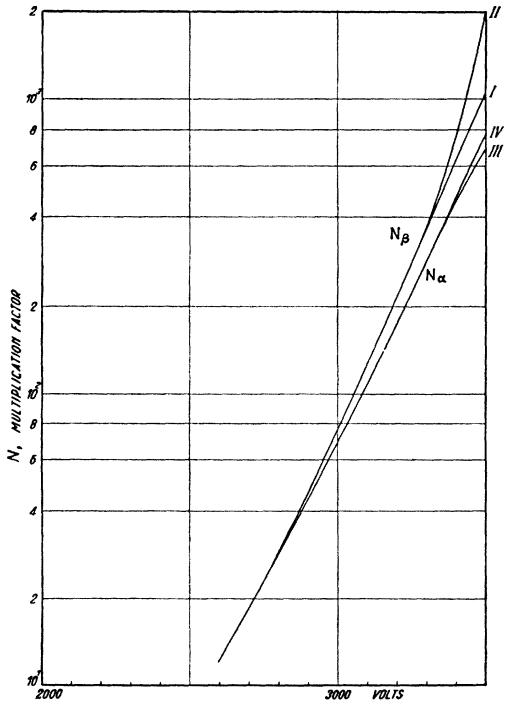

FIG. 1. Multiplication curves. Counter diameter: 90 mm; argon pressure: 76 cm Hg; I. β-particles $RC=1.5\,\mu$sec.; II. β-particles $RC=250\,\mu$sec.; III. α-particles $RC=1.5\,\mu$sec.; IV. α-particles $RC=250\,\mu$sec.; at $N=30$ the space-charge distortion of the multiplication begins for α-particles; at $N=400$ photo-electronic pulses are detectable. The Geiger threshold is at $N\beta=1000$.

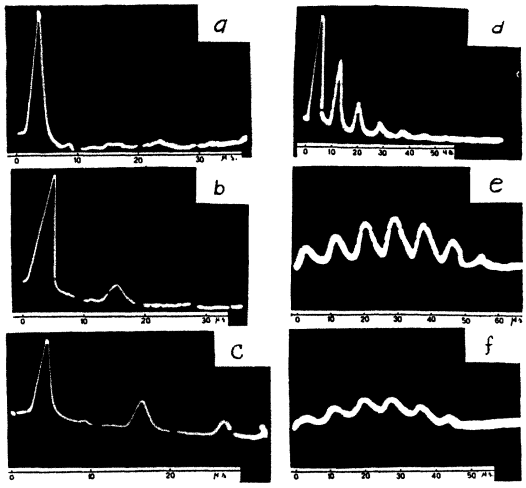

FIG. 2. Pulse shapes. Counter diameter: 90 mm; argon pressure: 76 cm Hg; a, b, c, d, are α-particle pulses. $N\alpha$ ranges from 50 to 700; and the electron transit time is 12 μsec.; e, f, are β-particle pulses in the Geiger zone. $N\beta > 1000$. The d pulse in one α-particle in the Geiger zone. Here $Nf\beta$ is >1 but $N_\alpha f$ is still <1.

adopting for the time constant a small value as compared with the transit time. The following pulses appear thus sharply separated from each other.

On the contrary, when a time constant is employed sufficiently large to sum up the whole series, a pulse is obtained whose amplitude is given, with the approximation referred to above, by

$$Q = A_0 N/(1-Nf).$$

The different behavior noted between the α- and β-particle curves at high N values is due to the distortion of the multiplication factor brought about by the large space charge produced by the α-particles, whose action is no longer negligible.

In the case of β-pulses, at a voltage $V > V_s$, where V_s represents such a voltage that $N_\beta f = 1$, an increasing-term succession results. But the ionic charge accumulated on the wire, after a few terms, lowers the field. Consequently the multiplication factor is reduced to such a value that $N_\beta f < 1$; then the succession will go on decreasing till it is exhausted.

This pulse is of the Fig. 2e,f type, its total amplitude is almost independent of the primary ionization of the particle; the Geiger threshold is at voltage V_s.

The sharp separation between the photo-electronic pulses of the succession and the fact that, even at its most remote terms, the rise times are approximately constant and equal to the first rise time, which is determined by the geometry of the primary ionization, prove that in our case the photo-ionization of the gas does not play an important role in the building up of the discharge.

In fact, this is entirely due to the photoelectric effect on the cathode. The f values which can be deduced for the counters employed range from 1/500 to 1/2000.

We thank Professor G. Bolla for useful discussions on the subject.

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Domain Structure of Rochelle Salt

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August 7, 1950

AS has been shown[1] in investigations on the domain structure of BaTiO, inspection by means of the polarization microscope is the most reliable method for the study of the domain structures of ferroelectric substances if the directions of the optic axes of a domain differ from those of its neighbors. We have found that this method is useful also for rochelle salt, and have verified that in general rochelle salt consists of many domains, between two Curie points.

Thin X-cut specimens of rochelle salt (0.07×0.3 mm thick) have been inspected between crossed Nicols and it has been found that generally the specimens consist of two kinds of regions which have slightly different extinction positions. One of the two extinction positions deviates by a small angle from the c axis to the right, and the other to the left. Generally the region is a band elongated along the c axis (Fig. 1). The band widths which have been observed are from 0.5 to below 0.001 cm. Specimens cut parallel to the b axis and oblique to the a and c axes also show similar structure, consisting of bands perpendicular to the b axis.

These facts show that generally rochelle salt crystal is a repeated twin whose component is a slab perpendicular to the b axis. There are, however, a few X-cut specimens which have groups of bands elongated to the b axis.

When the temperature is increased or decreased from room temperature, the twin structure disappears at about 23° and −18°C (the upper and lower Curie points), and when it is returned to room temperature almost the original structure reappears.

Observations on the effect of an electric field have been performed through pinhole electrodes. When a field is applied in the X direction the structure disappears, and when the field is removed it reappears; however, it is not similar to the initial structure after a strong field is applied for several minutes.

When a stress is applied the structure disappears and when the stress is removed it reappears, but a strong stress applied for several minutes leaves a remanent state.

These properties prove that the component of the twin is itself a domain.

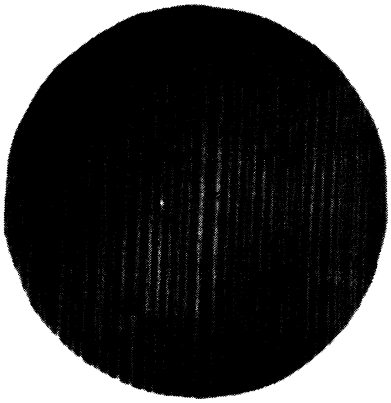


FIG. 1. X-cut specimen observed between crossed Nicols.

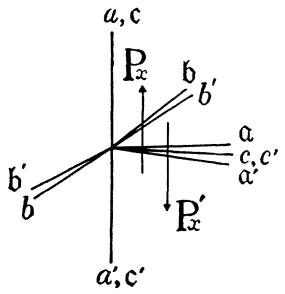
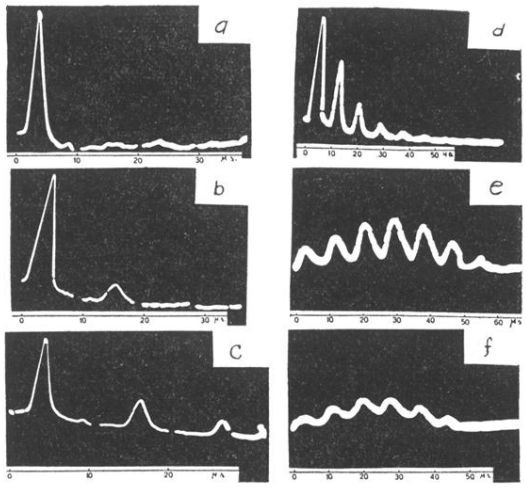


FIG. 2. Relation between the sense of polarization of a domain and its optic axes a, b, and c. The dashed letters are concerned with the domain for which the sense of polarization is downward.



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