Apparently the crystal: (a) absorbs infra-red radiation from the tungsten lamp and converts this to heat energy; (b) this heat is sufficient to raise the temperature of the crystal from approximately 20°C to above 120°C, the "Curie" point.

Evidence for (a) is the observation that after the crystal has become isotropic, a breath of cool air will cause it to revert to anisotropism momentarily. Also, the insertion of a light blue (daylight) filter in the optical system brings about a similar reversal to the anisotropic state. Observed under carbon arc illumination, the effect does not occur.

Evidence for (b) is that heating the crystal externally with the use of a Kofler micro hot stage, and examining it with the daylight filter in a low intensity light, shows a transition from anisotropic to the isotropic state at 122.0°C–123.0°C. This checks the oscillograph[2,3] and x-ray diffraction heating camera measurements[5] very closely.

An attempt was made to determine whether a selective absorption band existed for the crystal in the infra-red region. Tentative infra-red spectrometer measurements appear to show that the band is exceedingly broad.

The crystals appear in both bluish and yellowish colors. The latter do not seem to exhibit the infra-red absorption effect, although they show the same phase transformation at approximately 121°C in the micro hot stage. Both crystals appear to have the same lattice constants as those published earlier[4] for the microcrystals and the single twinned crystals grown from a $BaTiO_3$ melt, as shown by a Weissenberg moving film camera diffraction pattern.[7]

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Thallium Halide Crystal Counter

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October 16, 1947

THE photo-conductivity of thallium chloride, thallium bromide, silver chloride, and silver bromide has been studied by W. Lehfeldt.[1] He found that the thallium salts showed many similarities, in photo-conducting properties, to the silver salts. Van Heerden[2] has shown that silver chloride, when cooled to low temperatures, may be used to detect γ-rays, β- and α-particles. Therefore, it seems likely that the thallium salts may also act as particle detectors or counters. Van Heerden has already suggested this possibility.

It seemed worth while, therefore, to see whether a thallium halide would behave as a counter. Thallium crystals are rather rare in this country, but the author was fortunate in obtaining a sample of a mixed halide crystal through the kindness of Dr. H. C. Kremers of the Harshaw Chemical Company. This crystalline sample is a mixture of approximately 40 percent thallium bromide and 60 percent thallium iodide. The sample is a disk, one inch in diameter and two millimeters thick, orange in color, and seems to be a polycrystal, judging by its appearance in reflected light. The component crystals seem to be a millimeter or a few millimeters on a side.

This crystalline sample was sputtered with one-half inch diameter platinum electrodes, placed in a vacuum chamber, and cooled to liquid nitrogen temperature, at which temperature the crystal is an insulator. The crystal is a conductor at room temperature and is similar to silver chloride in this respect. When connected to an amplifier and voltage supply, the crystal showed no oscilloscope pulses in response to radium γ-irradiation. However the crystal did show photo-conductivity under these conditions.

The crystal was removed and placed in a furnace where it was brought to a temperature of 350°C. It was then slowly cooled to room temperature. During the annealing process the crystal was observed through crossed Nicol prisms so that its strain pattern could be observed. After annealing, the crystal showed very little strain and was transferred to the crystal holder and cooled, over a period of an hour or so, to the temperature of liquid nitrogen (77°K). When exposed to the γ-radiation of radium, pulses were observed on an oscilloscope screen. Thus, this mixed crystal will detect ionizing radiations when properly prepared. It seems very probable, therefore, that the pure materials, thallium bromide and thallium iodide, will also act as counters.

The largest pulses observed (0.2 millivolt), with 500 volts across the crystal, were only about five times the noise level of the Model 501 amplifier which was used in these tests. However, it is felt that much larger signals can be obtained from single crystals of the material. Moreover, the arrangement in which the crystal was mounted introduced a rather large stray capacitance to ground ($\sim$45 micro-microfarads). Nevertheless, the high dielectric constants of the thallium salts ($\sim$30) will tend to make pulses smaller than in silver chloride (dielectric constant $\sim$12) samples of the same dimensions.

A test was made at -115°C. The crystal counted at this temperature also. The rise time of the largest pulses was less than or equal to 0.4 microsecond at this temperature. From Lehfeldt's work it is probable that with pure compounds the thallium salts may insulate well enough to count at temperatures of -70°C. This crystal, however, was a conductor at -70°C. It has been noticed in this work that at -196°C and at higher voltages (>800 volts), direct current flow begins rather abruptly in or over the surface of the crystal. The fluctuations in this current form a background which increases the noise level considerably, until at higher voltages the pulses cannot be observed above the noise. The direct current component is observed even without a radioactive source present, and seems to depend in a non-linear way on voltage. Similar results have been observed in some silver chloride crystals which the author has used as counters. At higher temperatures (-115°C), the crystal showed "fatigue" in the sense that it became conducting after having voltage (500 volts) across it for ten minutes or so.

If some of the above difficulties can be overcome, the use of thallium compounds as γ-ray counters seems quite promising since such crystals are quite dense (TlBr 7.56, TlI 7.09). They are also interestingly complementary to diamond counters[3,4] since pair production and the photoelectric process have a high probability in the thallium salts, while at γ-energies below about eight million electron volts the Compton process is the only one of moment in diamond.

It is also interesting that an "impurity" of bromine in the iodine compound (or *vice versa*) still permits the crystal to count.

This work has been supported in part by U. S. Navy contract N6ori-105 Task I. I wish to thank Dr. H. C. Kremers for the crystal and Messrs. J. C. D. Milton and Chester Grove for their kind help with these experiments.

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A Calibration for Eastman Proton Plates

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A BATCH of Eastman nuclear research plates (NTB emulsion No. 347,126) has been calibrated by determination of the emulsion stopping power as a function of proton energy. Until there is some assurance of the reproducibility of Eastman NTB plates, it seems necessary to repeat the calibration procedure for every new batch received.

A thin boron target was bombarded with 3.7-Mev deuterons from the cyclotron, and Eastman plates were used to record the long-range protons from $B^{10}(d, p)B^{11}$. Several exposures were taken with different thicknesses of aluminum foil interposed in the path of the protons. Thus the same group was measured in each plate, with a different effective proton energy in every case. The extrapolated range of the group was determined from each exposure and identified with the extrapolated air range, suitably reduced according to the absorbers used. In this way the emulsion stopping power was determined at each of several proton energy values. The form of the curve so obtained is independent of the deuteron beam energy and the Q-value of the reaction. The absolute values of stopping power will, however, depend on these parameters.

The calibration function obtained is presented in Fig. 1. The errors shown are those which are effective in determining the form of the curve. To them must be added an uncertainty in the level of the curve as a whole, amounting to ±1.4 percent at 9 Mev. The stopping power function here obtained is constant down to about 5 Mev, below which it rises with decrease of energy. At 3 Mev the slope is -356 per Mev. Similar data obtained for Eastman Experimental Proton emulsion No. 340,506 (same composition as NTB plates) show a stopping power which is constant over roughly the same region, but which increases somewhat more rapidly at low energy.

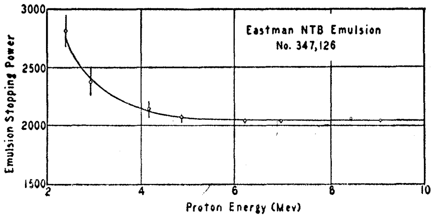

FIG. 1. Stopping power *vs.* energy (Mev) for protons in Eastman NTB emulsion No. 347,126.

For Ilford Nuclear Research emulsions ($B1$ and $C1$) Lattes, Fowler, and Cuer[1] have published a curve which is constant down to 5 Mev, below which it drops with energy decrease. Its slope at 3 Mev is $+70$ per Mev, roughly $\frac{1}{5}$ the corresponding slope for the Eastman emulsion. For Ilford halftone plates Richards[2] found stopping power slightly rising with decreasing energy, and a slope of -19 per Mev at 3 Mev, while Guggenheimer, Heitler, and Powell[3] have observed no energy variation of S for plates of the same type (Ilford halftone) between 2 and 6.5 Mev.

In attempting to account for the difference in direction of the stopping power variation at low energy as found for Ilford and Eastman plates, any slight differences in emulsion composition are of considerable importance. Thus the hydrogen and carbon in the gelatin exhibit a stopping power energy curve with negative slope, while for silver and bromine that slope is positive.[4] Since moisture content influences the amount of hydrogen present, relative humidity also has a considerable effect in determining the effective stopping power of an emulsion. From the different stopping power gradients reported for Ilford emulsions, and the two here found for the Eastman product, it appears that the quanties which vary from batch to batch of plates of a single type are able to evoke some variation in the energy dependence of the stopping power of such plates.

Sincere thanks are due Professor R. F. Humphreys for valuable discussions and suggestions.

* Assisted by the Office of Naval Research, under Contract N6ori-44.

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Saturation Effect in Microwave Spectrum of Ammonia

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October 22, 1947

IN his investigation of absorption line shape in the inversion spectrum of ammonia, Townes[1] has found that at low pressures and powers of the order of 1 μw a saturation effect occurs, causing the absorption to decrease and the width to increase with increase in power. Gordy and