disintegration by K-electron capture. Since only 0.7 L rays are to be expected for each K shell electron removed it appears that the isotope decays almost equally by L and K orbital electron capture.

From a study on a 257° mirror focusing spectrometer, the γ-ray energy was determined as 0.427 Mev. No evidence for a continuous beta-spectrum could be determined either in absorptions or on the spectrometer, and decay by beta-emission is less than 1/200 that by orbital electron capture.

The decay of electrons and electromagnetic radiations followed separately through over eight periods gave a value of 11.50 ± 0.05 days for the half-life after subtraction of background due to the 2.7-year Tl^{204}.

Note added in proof:—The limits in the value of the energy of the gamma-ray should read 0.435 ± 0.005 Mev.

* This work was performed under the auspices of the AEC.

[1] G. T. Seaborg and I. Perlman, Rev. Mod. Phys. **20**, 585 (1948).

Induced Absorption Bands in MgO Crystals

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ABSORPTION bands induced in single crystals of MgO by pile radiation and by high voltage electrons have been reported by Boyd, Rich, and Avery.[1] In this note we wish to report, without attempt at interpretation, measurements we have made of the optical absorption bands induced by 40-kv x-rays. We have found three distinct induced bands as shown in Fig. 1, two in the ultraviolet with peak absorption at 2200A and 2850A and a weaker broad band at 5250A. The visible band gives the exposed crystal a weak purplish tinge. This coloration, produced by exposure to ultraviolet light, has been reported by Hibben.[2] The two ultraviolet bands maintain a constant ratio of intensity which is equal to 2.1 at the wave-lengths given above for the peak absorption. There appears to be no fixed ratio between the intensity of 5250A band and the ultraviolet bands.

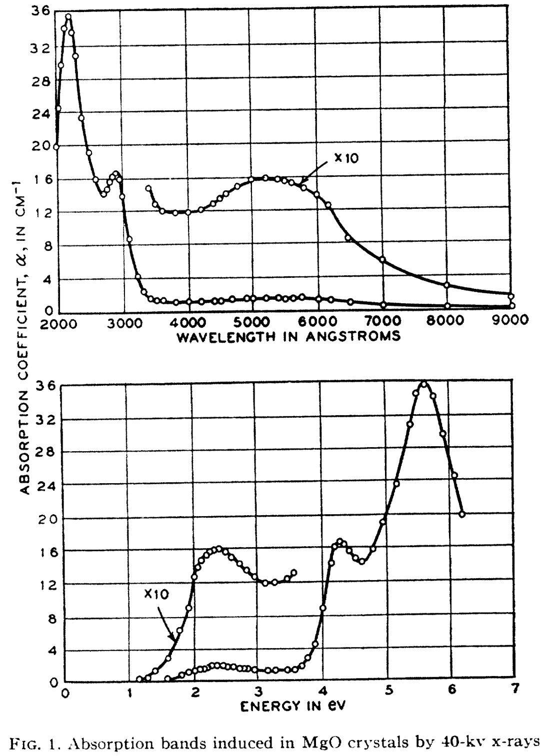

FIG. 1. Absorption bands induced in MgO crystals by 40-kv x-rays.

The build-up of absorption with time of x-ray exposure is shown in Fig. 2. We were able to fit the data for the 5250A band to an exponential formula of the type $\alpha=\alpha_0(1-e^{-kt})$, but the build-up of the ultraviolet bands proceeds slowly even after long exposure to x-rays, so no fit could be made to such a formula. The curves in Fig. 2 show also the decay in absorption which occurs when the crystals are kept at room temperature in the dark.

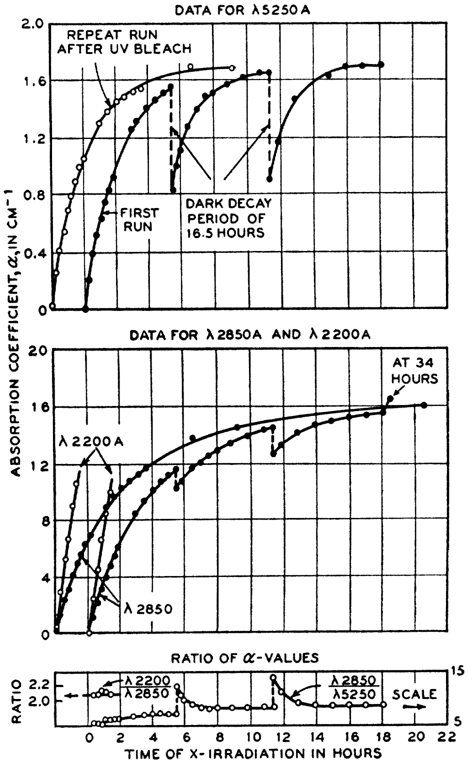

FIG. 2. The upper two plots give the induced absorption at the wave-lengths indicated as a function of the time of exposure of the crystal to x-rays. The lowest plot gives the ratio of the absorption coefficients for the wave-lengths indicated.

Light of wave-length anywhere in the range of the induced absorption bands will cause *all* bands to decrease in intensity. This experiment can be carried out most unambiguously when light in the wave-length range above 6900A is used. The data obtained in such an experiment are shown in Fig. 3. The absorption at 2850A and 5250A are seen to decrease with time of exposure, with, however, the absorption at 5250A decreasing more rapidly. The amount of decrease in the absorption coefficient, $\Delta\alpha$, at the two wave-lengths was found to be in constant ratio, thus suggesting that for each center giving rise to the 5250A absorption which is destroyed in the bleaching process, a constant number of centers giving rise to the 2850A absorption are destroyed. During the bleaching process the ratio of the intensities of the two ultraviolet bands remained constant.

When the induced absorption bands were measured on a crystal reduced in temperature to that of liquid nitrogen, only a very slight sharpening of the bands was found. The bleaching effects were qualitatively the same as at room temperature.

The x-rayed crystals were weakly luminescent. The light emitted could be detected by laying the crystal on a photographic film in the dark. The rate of decay of light emission seemed roughly comparable to the rate of change of the 5250A absorption band in the dark. The wave-length of emitted light was found, by interposing filters, to be in the range from 5000 to 6000A.

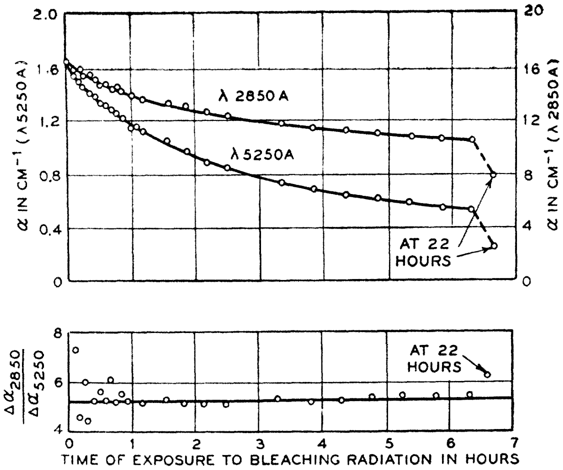

FIG. 3. The upper plot shows the effect of exposure to radiation from a tungsten lamp at wave-lengths greater than 6900A on the induced absorption at two wave-lengths. The lower plot gives the ratio of the *change* in absorption at these wave-lengths.

Attempts to make photo-conductivity measurements were confused and confounded by the presence of dark current which was variable during the course of measurement, and which undoubtedly contributed to a space-charge distortion of the electric field within the crystal. About all that can be stated with certainty is that after a crystal had been exposed to x-rays, visible light anywhere in the region of optical absorption gave rise to a change in the current through the crystal.

All measurements were made on samples obtained from the Norton Company, Niagara Falls, New York. Many of these were crystal clear, but some showed a slight yellow or greenish tinge. Others showed appreciable absorption in the ultraviolet before exposure to x-rays, as if they already contained centers giving rise to the 2850A and 2200A bands. The measurements we have here reported were made only on clear samples that exhibited a monotonically rising absorption in ultraviolet below 2500A. Spectrographic analysis revealed no impurities other than calcium (≈ 0.1 percent).

The authors wish to express their appreciation to Miss Dorothy M. Dodd of these Laboratories for operating the spectrophotometer used in the experiments reported here.

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[1] Boyd, Rich, and Avery, AEC Report No. MDDC-1508 (1947) (unpublished).
[2] J. H. Hibben, Phys. Rev. **51**, 530 (1937).

Further Studies of Infra-Red Absorption by Homopolar Diatomic Molecules

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IN an earlier note[1] a report of studies of the infra-red absorption spectra of liquid nitrogen and liquid oxygen was given. These studies revealed the presence of a strong absorption band with center near 6.4μ in the spectrum of liquid oxygen and a strong band near 4.3μ in the spectrum of liquid nitrogen. These bands appear at positions where absorption would be expected if the fundamental vibrations of O_2 and N_2 were infra-red active. Several possible absorption mechanisms were suggested. After the presentation of, but prior to the publication of the earlier report, the note by Crawford *et al.*,[2] appeared; these authors gave an account of their work on O_2 and N_2 at high pressures and in the liquid state. They presented evidence that the bands at 4.3μ and 6.3μ are due to absorption by collision-induced dipoles.

Since the publication of our first note further studies of the spectra of liquid N_2 and O_2 have been made by another group at this university,[3] and we have studied the absorption of dry O_2 and CO_2-free N_2 in a vacuum prism-grating spectrograph. These gases were studied at a pressure of approximately one atmosphere. Although the early prism studies of Snow[4] indicated the presence of weak absorption bands in gaseous O_2 and N_2, we failed to observe any absorption that could be attributed to oxygen or nitrogen molecules. Careful studies with 7500 line/in. and 3600 line/in. gratings revealed no rotational lines for either gas when a path length of 5 meters of gas at a pressure of one atmosphere was employed. The only changes observed when O_2 and N_2 were introduced to the spectrograph was an enhancement of the residual H_2O and CO_2 lines still observed when the spectrograph was evacuated as thoroughly as possible. On the basis of a rough determination of molecular absorption coefficients from measurements of absorption by liquids, a strong absorption was expected for a path length of 5 m in the gases. The absence of *any* observable absorption by the gases indicates that the close proximity of neighboring molecules is a necessary condition for the absorption process. Hence, this result supports rough theoretical calculations which indicate that processes involving magnetic-dipole and electric-quadrupole radiation do not contribute appreciably to the absorption observed for the liquids. Positive elimination of these two possibilities leaves us with only absorption mechanisms involving polymers and collision-induced dipoles as possible absorption mechanisms. Although we have obtained no evidence which would entirely eliminate the possibility of polymer formation in the liquid state, the results of the Canadian group[2] indicate that the collision-induced dipoles are chiefly responsible for the observed effects and we have obtained no evidence that is in disagreement with this hypothesis.

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[1] M. L. Oxholm and Dudley Williams, Phys. Rev. **76**, 151 (1949).
[2] Crawford, Welsh, and Locke, Phys. Rev. **75**, 1607 (1949).
[3] A. L. Smith, W. E. Keller, and H. L. Johnston, Phys. Rev. **79**, 728 (1950).
[4] C. P. Snow, Phil. Mag. **8**, 369 (1929).

Total Charges of Fission Fragments in Gaseous and Solid Media

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IN earlier experiments[1,2] the total charges of fission fragments emerging into vacuum from a uranium layer were determined by a measurement of the curvature of the paths described by the fragments in the magnetic field of the cyclotron. Recently further experiments have been carried out by means of a new deflection apparatus similar to the earlier one, but constructed in such a manner that the space between the uranium layer and the ionization chamber used for detection could be filled with a gas to any desired pressure. At not too high pressures the variation of the mean charge, e, and the velocity, v, along the path inside this deflection chamber can be neglected, and at the same time the pressure may be sufficiently high to ensure that equilibrium between capture and loss of electrons by the fragments will be established in the first few millimeters of the path, the entire length of which inside the deflection chamber is 200 mm. In this case the deflection will be proportional to the mean charge of the fragments in the gas considered. If the deflection chamber is evacuated, the deflections will be proportional to the charges of the fragments in the uranium layer, when the latter is uncovered. By covering it with a thin layer of another metal one obtains the charges in this metal. In the same way as earlier,[2] the charges were determined for each of the two groups separately.