

made by observing the critical frequencies of this region. Since the critical frequencies are a measure of the ionization, it is seen that this whole process is merely a different way of measuring solar activity. Of course we would not be justified in using this method if other factors entered in such a way as to confuse the result. It is believed that the correlation results shown in this note indicate that other factors, if present, can be ignored, at least to the first approximation.

From the point of view of the ionosphere, there are a number of interesting points which for completeness should be discussed. Limitation of space, however, requires that this phase of the subject be discussed elsewhere. It may be pointed out, however, that for constant solar activity at other times than at minimum activity, the monthly average critical frequencies have two maxima, one in February–March and one in October. This may be seen in Fig. 1. A similar effect is well known for magnetic activity.

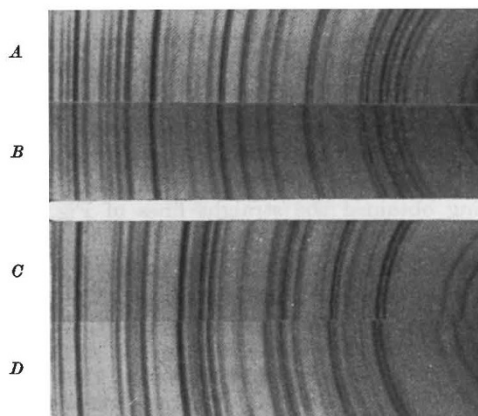
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¹ "On the Ionization of the F_2 Region." *Proc. Inst. Radio. Eng.*, 25, Nov. 1937.

Position occupied by the Activator in Impurity-activated Phosphors

ALTHOUGH it is often assumed that the activator in impurity-activated phosphors is in solid solution in the matrix of the material, direct evidence of this



X-RAY PATTERNS OF ZINC ORTHOSILICATE (A) PURE, AND (B) CONTAINING MANGANESE; CALCIUM TUNGSTATE (C) PURE, AND (D) CONTAINING LEAD.

has hitherto been lacking. Recently, G. R. Fonda¹, in a general paper on fluorescence, mentions briefly that he has found an expansion of the lattice due to manganese in the case of zinc orthosilicate, but gives no experimental details.

During the past twelve months, we have investigated an extensive range of impurity phosphors by the X-ray method and have been able to demonstrate in several cases a measurable change in the lattice dimensions of the matrix material due to the presence of the activator. Among the phosphors for which lattice changes have been detected may be mentioned zinc beryllium orthosilicate, calcium tungstate and zinc orthosilicate.

The X-ray patterns were taken in a 10 cm. diameter diffraction camera of the type described by Bradley

and Jay², with knife edges arranged to cast a shadow at an angle of 170°. A and B in the accompanying reproduction illustrate the difference between pure zinc orthosilicate and a zinc orthosilicate containing 2½ per cent manganese by weight added as manganese nitrate. The displacement of the lines away from the knife edge shadow from the positions for the pure material, corresponding to a lattice expansion, will be noted. The magnitude of the lattice expansion can be seen from the accompanying table, in which the interplanar spacings for two or three lines at the high diffraction angle end of the X-ray patterns for three different percentages of manganese are recorded. It is clear that this is the kind of lattice change to be expected from the replacement of zinc atoms by manganese atoms, and the activated phosphor can be regarded as a solid solution of manganese orthosilicate and zinc orthosilicate.

INTERPLANAR SPACINGS NEAR DIFFRACTION ANGLE 85° FOR ZINC ORTHOSILICATE ACTIVATED BY VARIOUS PERCENTAGES OF MANGANESE (COPPER $K\alpha$ RADIATION).

Copper K radiation	0% manganese	1% manganese	2½% manganese
a_1	0.7723 ₂	0.7728 ₂	0.7733 ₂
a_1	0.7739 ₂	0.7745 ₂	0.7753 ₂
$a_1 a_2$ (mean)	0.7867 ₁	0.7873 ₂	0.7878 ₁
$a_1 a_2$ (mean)	0.7911 ₂	0.7917 ₂	0.7923 ₁

Calcium tungstate is representative of a class of phosphor in which the deliberate introduction of an activator is not essential for the production of luminescence. Lead is, however, sometimes used as an activator in calcium tungstate, the effect being to shift the centre of gravity of the fluorescent band towards longer wave-lengths. The X-ray patterns in C and D clearly show the solid solution effect in the case of calcium tungstate activated by approximately 3 per cent by weight of lead.

It is hoped to publish the results in more detail elsewhere.

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¹ *Trans. Inst. Elec. Eng.*, 57, 677 (1938).

² *Proc. Phys. Soc.*, 44, 563 (1932).

Luminescence and Photoconductivity of Solids

WHEN ultra-violet radiation is absorbed by atoms in a solid, one of two things may happen. Electrons may be freed from the parent atoms or impurity centres, in which case these electrons are able to take part in conduction processes and are said to be in the conduction band. On the simplest view, it follows from this that photoconduction is to be associated with a hyperbolic decay law. On the other hand, electrons may be raised to states lying below the conduction band, in which case the electrons are still bound to the parent atoms and are unable to take part in conduction. Electrons in this condition are said to be in excitation states, and the phosphorescence decay law should then be exponential.

We have carried out measurements on the photoconductivity and phosphorescence decay curves of a large number of luminescent solids, and from the results have obtained direct evidence of excitation