

A New Method for the Demonstration of Self-Excitation

By L. SZALAY and L. SZÖLLÖSY

Introduction.

On dealing with investigations concerning Lenard phosphors different authors suggest the possibility of self-excitation. This means that the phosphor can be excited by light of its own emission. In most cases the process of self-excitation was only assumed, but could not be proved.

Riehl (1) was the first to establish self-excitation by a direct method in a series of tedious experiments. He found that the self-excitation was slight. In phosphor mixtures self-excitation can also be expected if the emission band of one of the components and the absorption band of the other have a common area. Such self-excitation was also observed in the case of Lenard phosphors (2).

As regards gelatine phosphors self-excitation can be theoretically assumed. P. Fröhlich and H. Mischung have shown that the emission band (3) and absorption band (4) of acridine orange have a common area. Taking into account the very slightness of the intensity of the phosphorescence emission, as compared with the usual intensity of exciting light, and on the other hand that only a small part of the emission band is absorbed, only a very slight self-excitation effect can be expected.

Self-absorption was also experimentally proved by G. N. Lewis and his co-workers (5). Concerning the analysis of the emission band of fluorescence P. Ször also considered the possibility of self-absorption (6). Recently P. Fröhlich and P. Ször elaborated a method for the calculation of the emission band freed from self-absorption (7).

According to previous investigations of one the authors the existence of self-excitation was presumed (8). During the measuring of the time of the saturation half of the preparation was covered by means of a screen and the other half was saturated. After the removal of the screen the time needed for the disappearance of the distinct boundary line dividing the saturated and unsaturated sections was measured. It could be observed that the non-pre-excited surface does not exhibit a uniform light distribution during excitation, but lightens from the boundary line towards the border. It can be assumed that the phosphorescence emission of the molecules on the border of the dark surface increases the intensity of the exciting light, consequently the dark surface close to the boundary line is saturated first.

In this paper a method has been elaborated concerning the direct determination of self-excitation in the case of rigid phosphorescent gelatine solutions which have an extremely short time of decay; at which it was not possible to apply Riehl's method.

A rigid gelatine solution of acridine orange was used. The solution had a concentration of $10^{-2.25}$ gr dyestuff (cm^3 dry gelatine). The preparations were made by the method of P. Frólich (9).

The thickness of the plate was 0.1 mm.

Method and Results.

For the direct determination of self-excitation the Bequerel phosphoroscope (10) was modified.

On the axis (t) of the two discs (I. II.) of the phosphoroscope a third disc (III.) also having 4 openings was adjusted (Fig. 1). The discs were placed into a cylinder shaped metal case each of the two oppositely situated walls having an opening at the height of the opening of the disc. The discs were situated on the axis at a distance of about 3 cm. Thus the gelatine plates could be placed between discs I, II and II, III. The gelatine plates were mounted on a metal frame fitting into two openings of the upper part of the cylindrical case.

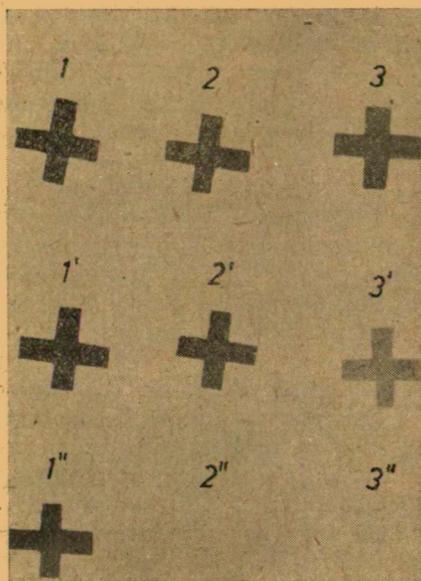
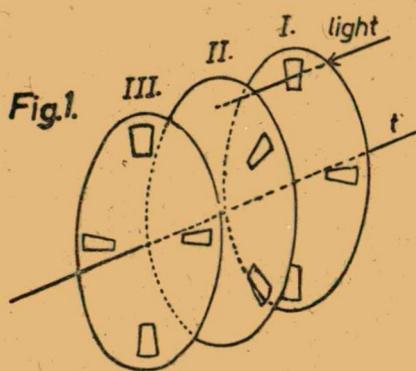


Fig. 2.

Into this phosphoroscope 2 pieces, cut out of the same plate, were inserted. If the phosphoroscope was in the position shown in Fig. I. the exciting light excited the preparation placed between discs I. II., but could not reach either the space between discs II. III. or the observer in front of disc III. If the rotating discs described an angle of 90° the phosphorescence emission of the plate placed between discs I. II. excited the preparation inserted between discs II. III.

However, the light could not yet reach the observer. After a made an angle of 90° the phosphorescence emission of the plate placed between discs I. II. could not reach the space between discs II. III., but the phosphorescence emission of the plate inserted between discs II. III. previously excited by self-excitation could be observed through the opening of disc III.

Thus on rotating the phosphoscope the phosphorescence emission due to self-excitation can continually be observed through the opening of disc III.

As was already mentioned the energy needed for self excitation is very slight. Therefore the phosphorescence emission caused by self-excitation could not be visually observed.

The preparation placed between discs I. II. was excited by means of a tungsten filament lamp of 1000 W. and the self-excitation was observed photographically. A camera was adjusted in front of the opening of disc III. and the photographic plate covered with a black paper having a cross-shaped slit. The occurrence of self-excitation was established through the blackening of the plate on the area of the slit.

The whole apparatus was carefully constructed enabling the light only to reach the photographic plate from the self-excited preparation. Yet to ascertain if the blackening is not after all caused by the dissipated light, or if the preparation between discs II. III. is not excited by it, the photographic plate was exposed under the same conditions, to the light coming from the opening of disc III. in the following cases:

1. Pure gelatine was placed between discs I. II. and also between II. III.
2. Pure gelatine was inserted between discs I. II., and a gelatine dyestuff solution between II. III.
3. Gelatine dyestuff solution was put between discs I. II and II. III.

The blackening caused by the dissipated light is shown in Fig. 2. picture 1., picture 2. demonstrates the effect of the dissipated light and the excitation caused by it, finally picture 3. the blackening caused by the dissipated light and the excitation effected by it and the phosphorescence due to excitation.

Orthochromatic „Forte“ plates sensitized particularly for green were used, the experiments showed that after three hours exposure a satisfactory blackening was obtainable.

Three series of pictures were made under the conditions mentioned above, Fig 2. shows each of the series in a row. The crosses denoted with 1, 2, 3, belong to the first series. Picture 1 was taken with gelatine dyestuff solution, picture 2 with pure gelatine and gelatine dyestuff solution, picture 3 with pure gelatine between the discs.

Fig. 2. demonstrates well that picture 1 exhibits the greatest extent of blackening which was also caused by self-excitation. In the second series (1', 2', 3') the same can be observed. In the case of the third series picture 1" shows blackening, indicating that only the phosphorescence emission caused by self-excitation reached the photographic plate. This was attained by reducing the area of the opening to 1 cm², thus eliminating more completely the dissipated light. Picture 2" and 3", on which there is no blackening, were also taken with a 3 hours exposure. Hence cross 1" is exclusively produced by the phosphorescence emission caused by self-excitation.

Of course all the pictures belonging to the same series were made under the same conditions i. e. the same photographic plate, exposure and development were applied.

Summary.

A new and rapid photographic method for the establishment of self-excitation was elaborated which can also be applied to objective measurements. Self-excitation was shown in the case of rigid gelatine solution of acridine orange.

The measurements were made at the Physical Institute of the University of Szeged.

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On the Structure of Gelatine

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Introduction.

Many investigators have dealt with the structure of gelatine approaching the problem from the chemical and physical point of view. According to earlier investigations carried out with X-rays no crystal interference could be observed. Two diffuse fringes were found, hence it was established that gelatine is a mixture of two amorphous substances (1). Further roentgenographic examination showed the X-ray diagram of gelatine to have a typically broad fringe, surrounded by another distinct one characteristic of crystal interference. A second diffuse ring can also be observed (2). On stretching the gelatine the diffuse fringe characterising the amorphous state changes and resembles the distinct interference ring.

It was assumed that in a normal state gelatine is probably a crystalline substance possessing a very disordered structure having, however, periodicity in one direction. On the other hand, it was also suggested that the distinct fringe is caused by parallel elements but not by a lattice structure.