ABSORPTION AND THERMOSTIMULATED ELECTRON EMISSION
AND LUMINESCENCE OF LiF CRYSTALS BOMBARDED
WITH ALPHA PARTICLES

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The paper gives the results of measuring the absorption and thermostimulated electron emission
and luminescence in the same kind of LiF crystals irradiated with X-rays and alpha particles.
The different method of excitation has the consequence that the curves of the three phenomena
are to a certain extent different. The possible causes of these differences are discussed.

1. INTRODUCTION

The absorption of LiF crystals, irradiated with neutrons, X-rays or 1 MeV
electrons, was studied by Delbecq and Pringsheim [1] and these authors together
with Yuster [2]. The results given by Delbecq et al. substantially agree with our
absorption curve b in Fig. 1. Somewhat different results were obtained by Uchida
and Yagi [3] who studied mainly the structure of R bands (cf. also [4, 5]). This was
concerned with the optical transitions of electrons in one and the same centre.
Uchida, Kato et al. [6, 7] paid attention to the optical properties of LiF crystals
in the ultra-violet region. According to them, the basic absorption edge should lie
further away than at 900 Å. Freytag and Schreiber [8] deduce that the absorption
band corresponding to the OH group lies at about 985 Å, in the infra-red region of
the spectrum at 2.76 μ.

The thermostimulated electron emission (TE) and luminescence (TL) of LiF and
NaCl crystals were studied by Hanle et al. [9] and Bohun [10]. Hanle et al.
irradiated their kind of LiF crystals with alpha rays and electrons having an energy
of 3 keV. They found that the kind of irradiation substantially influences both the
existence and the interrelation of TE and TL. The authors tried to explain this different
behaviour of differently irradiated samples by the existence of a Frenkel surface
dipole layer, applied to exoelectron emission for the first time by Matyáš [11].
Bohun (loc. cit.) showed that different samples of LiF crystals, equally irradiated
with X-rays, have very different courses of both TE and TL. He also showed that
the courses of the two phenomena strongly depend on the dose of X-rays. In a review
article [11] he pointed out that the work of Jech [12] and other results of studying
the interaction of corpuscular radiation with a solid show that the influence of the
different kind of radiation on the physical properties of the crystals of alkali halides
must be dealt with much more thoroughly than hitherto.

The present paper is intended as a contribution towards solving this problem. It aims at giving the results of measuring the absorption, TE and TL of LiF crystals
irradiated at room temperature with X-rays and alpha-rays.

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2. SAMPLES AND MEASURING EQUIPMENT

In order to be able to compare earlier results obtained on crystals irradiated with X-rays \([10]\) with those achieved here after irradiating with alpha rays, LiF crystals from the Research Institute of Single Crystals in Turnov were used as the samples. The crystals were grown in vacuum. They contained a fair amount of Mg and traces of Fe. Along the 2·8\(\mu\) band the crystal is only slightly hydrolyzed. Samples of about 10 \(\times\) 5 \(\times\) 1 mm and 3 \(\times\) 3 \(\times\) 0·5 mm were cut from them to measure the absorption and the TE and TL respectively. The usual conditions were observed in irradiating with X-rays (X-ray tube AEG 50 T, beryllium window, 50 kV, 30 mA, distance of crystal from focal point about 4 cm). Po\(^{210}\) 53 mc was used for the alpha irradiation. The crystal lay at about 2 mm from the latter. The irradiation time was 24·5 hrs or 2 and 20 min.

The absorption was measured on a CF-4 spectrophotometer from the firm Optica-Milano. The TE and TL were measured on the apparatus described e.g. in [11]. The emitted particles were indicated by an open point counter in air, the luminescence by a FEU 18 photo-multiplier. The heating rate was about 1·8 degrees per second.

3. RESULTS OF MEASUREMENTS

The absorption curves of LiF crystals strongly irradiated with alpha rays (curve \(a\)) and X-rays (curve \(b\)) are shown in Fig. 1. Curve \(c\) in the same figure shows the absorption in a crystal irradiated with alpha rays to yellow-green, then heated to about 320\(^\circ\)C, when it turned light brown, and cooled to room temperature at which it was measured.

Figure 2 shows the simultaneous curves of TE (curve \(a\)) and TL (curve \(b\)) of an LiF crystal strongly irradiated with alpha rays. Figure 3 gives the same curves for a crystal irradiated with X-rays. Despite the fact that the TE and TL become more pronounced at high temperatures as the X-ray dose increases, not even after several hours of irradiation with X-rays could the TE and TL maxima be found to lie at such high temperatures as in crystal bombarded with alpha rays. On the other hand, i.e. when the dose of alpha rays was small, the curves below 600\(^\circ\)K were similar to those for crystals irradiated with X-rays but around 700\(^\circ\)K only TE had a maximum and this was the most pronounced.

Fig. 1. Absorption of LiF crystals irradiated 24·5 hrs with alpha rays. Notation of curves is explained in text.