CATHODE LUMINESCENCE PROPERTIES OF ORGANIC LENGMUIR-BLODGETT FILMS

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Some investigation results of the β-sensitivity of organic Lengmuir-Blodgett (LB) films irradiated with an electron beam are described. The dependences of the integral luminescence (Δλ=380-450nm) on the electron energy (0.2...6kV) with a constant density (0.05...4.0μA/cm^2) are represented. The possible spheres of LB films application as scintillator detectors of ionizing radiation are discussed.
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1 INTRODUCTION

Now alongside with a traditional radiation sensitive monocrystal scintillator a good prospect of practical application can have thin organic LB films, activated by organic luminophore. Scintillators, made on base of LB films, can appear especially effective at the registration not only of UV radiation but also of low-energy electrons, soft X-rays, heavy particles and low-energy fission fragments. The increased sensitivity of these films at registration of a short-range of particle paths and radiation is caused by the dense packing of the luminophore molecules in monomolecular layers [1]. Depending on the order of alternation of these monolayers containing donor-acceptor pairs, it is possible to raise a sensitivity of the all structure for registration of β-radiation [2]. This report contains description of experiments on excitation of the LB film samples by UV radiation and the low- energy electron flow.

2 LUMINESCENCE MATERIAL AND MESUREMENT TECHNIQUES

The experiments were carried out on the film sample, consisting 1000 monolayers of polymer tetraphenylbutadiene dope with 10% concentration of gram-molecules and overall thickness of 1.0 μm. For formation on a water surface of stable two-component monolayers and transference them on a glass substrate with thickness of 1mm and diameter of 13 mm we used a two-bath installation NIOPIK checked by a computer. The UV absorption spectra were measured on a spectrophotometer SPECORD M-40. The photoluminescence was raised by a guartz flashtube DKSSH-150, from which by a monochromator the light with a wavelength of 350 and 260 nm has been cut out. The typical luminescence spectrum of the sample described is given in Fig. 1.

For measurements of the radioluminescence intensity from the sample irradiated with an electron flow the installation was assembled. Its diagram is shown in Fig. 2. The presence in a design of electrostatic deflecting plates allows not only to decrease a light noise from the filament of the electron gun but also to direct onto the target an electron beam with a small disorder in speeds. A tungsten wire filament provided the current

density up to 4.0μA/cm^2 with variation of the anode voltage (U_a) from 0.2 to 6 kV. The pulse length was 20ms with an operating frequency of 50 Hz. A dimension of the spot on the target was near 7 mm. In the chamber a vacuum of 10^{-5} Torr was provided by a criogetter pump [3].
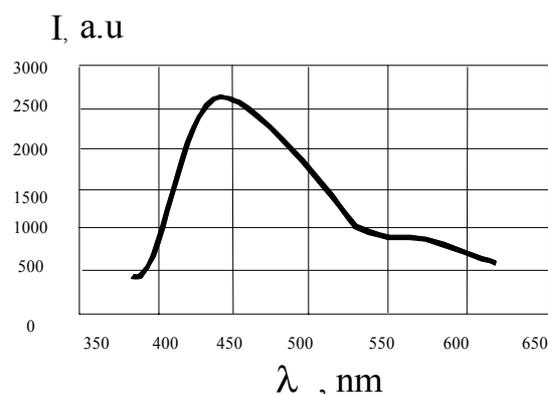
Fig. 1. The photoluminescence spectrum of the sample described.
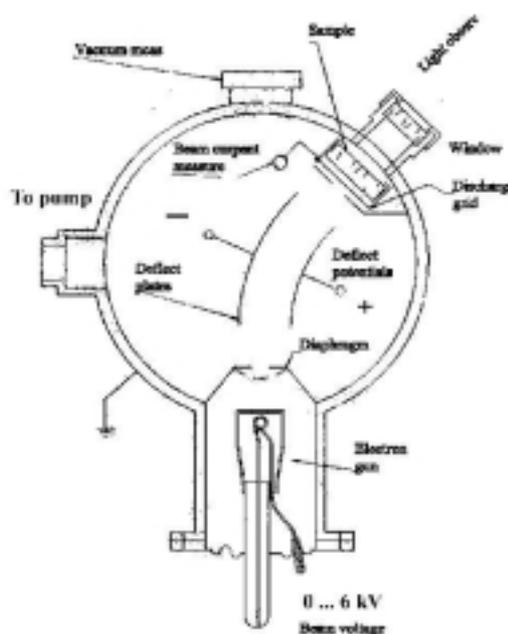
Fig. 2. The installation for irradiation of samples with electrons.

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The relative luminous emmitance of samples was measured at a current of the photomultiplier (Ph.M.-68). One operated in the current regime in the range of its maximum spectral response ($\Delta\lambda$=380-480 nm).

3 EXPERIMENTAL RESULTS AND DISCUSSION

During investigations we measured the target current and Ph.M. current as a function of the electron gun U_a at the constant current on the target equal to 2 μA. The typical oscillogram of the electron current on the sample and the Ph.M. signal are shown in Fig. 3.

Fig. 3. Oscillograms of the electron current on the sample (a) and the Ph. M current (b).

The average value of Ph.M. current versus anode voltage is presented in Fig. 4.
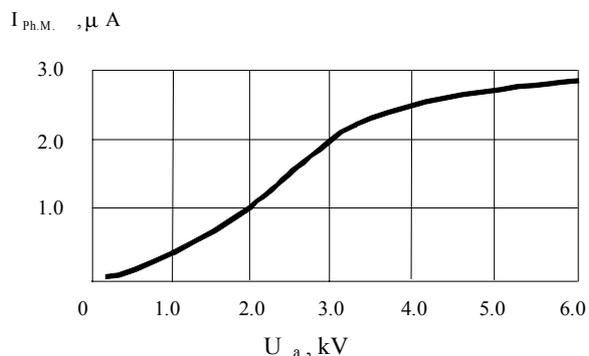
Fig. 4. Photocurrent versus anode voltage of the electron gun. I_t=2 μA; $U_{ph.M}$=900 V.

As is seen on this plot the distinguished signal originates already near 200 V. Then there is approximately a linear growth and after 3-4 kV it is set in saturation.

The minimal starting current density of the electron beam for a luminous emitting from our sample is 0.05 μA/cm^2. The linear growth of the glow intensity with the current density is observed to 4 μA/cm^2.

The results obtained may be explained as follows. If to suppose that a number of excitation acts is directly proportional to the range of an electron path in a luminophore layer, then the luminance of glow must depend linearly on a depth of the electron penetration into the layer. The depth of penetration may be estimated as x=Cv^4 (C is the constant, v is the electron velocity. Since v~ $\sqrt{U_a}$ (U_a the anode voltage), it is possible to suppose that the luminance is proportional to the square of accelerating voltage.

However in the Fig. 3 one can see that this dependence is nearer for the linear one.

The estimation shows that the electron path on U_a = 4 kV becomes larger then a film thickness of (1.0 μm) and they do not meet the excitation centers. The Ph.M. current in the Fig. 3 gets the saturation.

Thus, the obtained experimental results on the excitation of cathode luminescence in LB films apparently can form the basis for more detailed research of luminous output optimization.

However it is possible to assume now, that LB films may be used as a detector of the low-energy electrons (β-particles). The conventional organic molecular single-crystal detectors are low-effective in the low-energy region.

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