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EFFECT OF ADVANCE EXPOSURE ON THE SENSITIVITY OF THE UV-2T FILM TO SHORTWAVE ULTRAVIOLET RADIATION

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SUMMARY

The influence is investigated of the background created by all sorts of radiations (electrons, gamma-quanta and light) on the sensitivity of the UV-2T film to shortwave UV-radiation.

An effect of sensitivity increase is noted in the case of preliminarly exposed photolayer to radiation with wavelength λ = 584 A. The assumption is made about a mechanism of latent image formation in a photolayer subject to advance exposure.

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An increased interest has been noted in the course of the latest years to the study of vacuum UV-radiation of the Sun and the stars. Photographic materials have been extensively used as detectors in these investigations.

During extra-atmospheric investigations the photomaterials are subject to a veiling (hazing) action of ionizing radiations of cosmic origin. As a result of background formation the characteristic of photographic layers change. The variation of the latter, designed for operation in the visible part of the spectrum, with preliminary irradiation by gamma-rays, is described in the works [1 - 4].

The variation of the characteristic of photomaterials registering the UV-radiation as a result of their hazing by ionizing radiation was not studied. In the meantime the action of the UV-radiation has certain specific peculiarities: 1) because of strong radiation absorption in silver gelatin and halide, all the blackening forms in the most superifical part of the photographic layer, while the background is is spread of the whole thickness of the emulsion layer;

2) the UF-radiation quanta are more effective in the formation process of latent image than the quanta of visible light.

In connection with this it appears to be interesting to investigate the influence of advance irradiation on photographic characteristics of layers designed for operation in the region of shortwave UV-radiation.

METHOD OF INVESTIGATION

Investigated in the work was the influence of background exposures by electrons, γ-radiation and light on the photographic properties of the UV-2T film [5] utilized at photographing the region of the spectrum 2000 – 200 A.

Prior to exposure by UV-radiation the film was irradiated by a dosed electron beam with energy E = 80 kev on an electron sensitometer [6], by gamma-radiation of Co^{60} or light on a color sensitometer -TSC-2 with neutrally grey filters of different density.(*)

The photographic characteristics of the film were studied in the aveuum UV-region of the spettrum for radiation with wavelengths 584 A and 1215 A with the aid of a DFS-6 spectrograph, and in the ragion of the quartz UV for radiation with wavelength 2302 A with the aid of an ISP-22 apectrograph. A high-voltage arc discharge in technical helium served as the source of UV-radiation [7]. A PRK-2 mercury lamp served as the source of quartz UV. The sensitivity of the photolayer was determined by the density D = 0.3 above the veil's density.

EXPERIMENTAL DATA

Action of Electrons. The film samples, irradiated by various aggregate fluxes of electrons were loaded in spectrograph's cassette, exposed to UV-radiation and revealed in the course of 8 min in a D-19 developer at a 20°C temperature.

Plotted in Fig.1 (next page) are the curves of film's sensitivity S dependence on the density of the background of advance irradiation (D_ϕ). The sensitivity of control (non-irradiated) samples S_k was taken for the unity.

(*) [All instrument denominations have been transliterated because of the impossibility of determining the English equivalents]

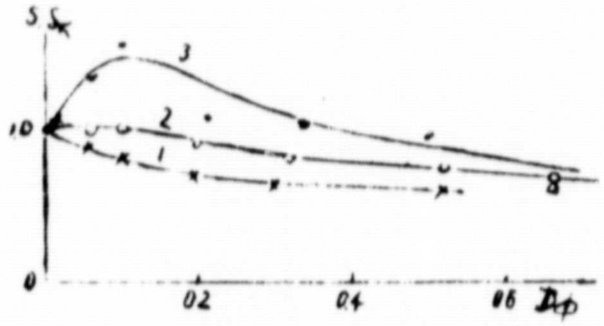

Fig.1. Dependence of sensitivity to UV-radiation on background density at advance irradiation by electrons with E = 80 kev
1) λ = 2302 A; 2) λ = 1215 A; 3) λ = 584 A

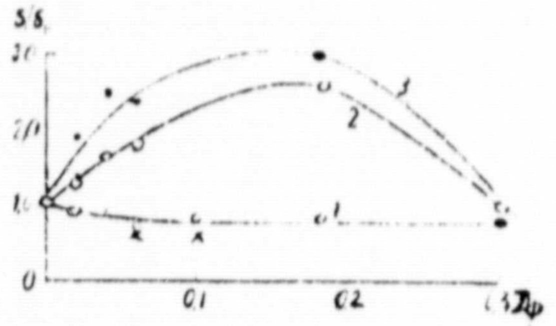

Fig.2. Same in case of irradiation by gamma-quanta (E = 80 kev)
1) λ = 1215 A; 2) second order of line λ = 584 A; 3) first order of line 584 A

As follows from Fig.1 for the line 584 A the sensitivity is notably increased for D_ϕ values from 0.06 to 0.2 (about by a factor of 1.5 in maximum); then the sensitivity gradually decreases and at density $D_\phi = 0.3$ it is equal to the sensitivity of the non-irradiated sample.

For the lines 1215 and 2302 A drop in sensitivity is observed as the background density increases. The magnitude of the contrast factor for each wavelength remains constant within the limits of experiment error; $\gamma_{2300} = 1.8$; $\gamma_{1215} = 1.1$; $\gamma_{584} = 0.85$.

Action of Gamma-Radiation. The character of film sensitivity variation with the increase in the density of the background formed by γ-rays (Fig.2) is analogous to the above dependence of sensitivity on the density of the background formed by electrons. On irradiated samples, the maximum attainable sensitivity for the line 584 A exceeds by about a factor of three the sensitivity of the non-irradiated film. The sensitivity of the UV-2T film to lines 1215 and 2302 A decreases somewhat to values $D_\phi = 0.2$ and then remains constant.

The DFS-3 spectrograph was built according to a scheme with oblique incidence angles of the ray. As the wavelength decreases, so does the angle of incidence of radiation on the surface of the photolayer. According to data of work [8], lowering of the value of the contrast factor of the photomaterial is observed with the increase of the angle of incidence. In order to show that the obtained results do not depend or are little dependent on the incidence angle, the variation of sensitivity with the increase of background density for the second order of line 594 A (2 x 584 A) was determined. The second order of line 584 A and the line 1215 A are situated alongside, so that the angle of incidence is practically identical.

According to Fig.2 (curve 2), the dependence of sensitivity on background density, observed for the second order of line 584 A, is similar to the dependence S f($D_{ф}$) for the first order of line 584 A (curve 3), while the sensitivity of the photolayer to the line 1215 A, disposed alongside, (curve 1) does not increase.

Therefore, one may consider that the factor, determining in the given case the rise of sensitivity, is not the variation of the angle of incidence, but the energy of UV-radiation quanta.

Action of Light. The dependence of sensitivity on background density of the light exposure is presented in Fig.3. The initial irradiation by light is analogous to the action of electrons and of γ-radiation and increases the sensitivity of the photolayer for λ = 584 A. A certain drop in film sensitivity is observed with the increase of background density, just as is the case at advance irradiation by electrons for wavelengths 1215 and 2302 A. The magnitude of the contrast factor for lines 584 and 1215 A decreases also by a about 25% simultaneously, and for the line 2302 A, it does so almost by 40%.

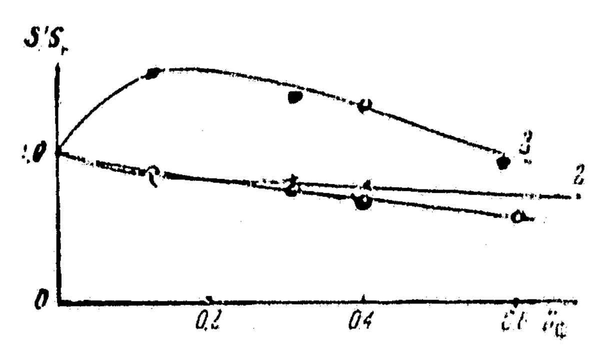

Fig.3. Dependence of the sensitivity to UV-radiation on backgr. density at advance light exposure: 1) λ = 2302 A; 2) λ = 1215 A; 3) λ = 584 A

DISCUSSION OF THE RESULTS

It was shown in a series of works [1 - 4] that the advance irradiation by ionizing radiation and by light leads to a decrease of light sensitivity of the photomaterial According to [3], the decrease of sensitivity to light is explained by the fact that, as a result of advance irradiation, the most sensitive microcrystals pass into the composition of background.

On the other hand, it is well known that the a short-lived advance exposure to light of high intensity may increase the initial sensitivity of the photolayer at the expense of latencification of the centers of sensitivity [9].

It may be considered with well known approximation that the photographing action of ionizing radiation is analogous to short-lived action of highly intense light. Thus, following are the processes that compete at advance irradiation:

1) departure of part of crystals to background compostion; 2) latensification by advance (preliminary) irradiation. If the first process prevails, a decrease in sensitivity is observed at following exposure. In the case, when the second process is determining, the sensitivity of the layer subject to preliminary irradiation, may increase.

The UV-2T film dependence (Fig.1 - 3) on radiation with wavelength 1215 A may apparently be explained as follows: at average or high doses, a greater and greater part of microcrystals is veiled by advance irradiation and the sensitivity decreases. As to the latensification effect, it is insignificant.

The increase of sensitivity to radiation with wavelength 584 A is apparently conditioned by the fact that, in this case, a more substantial part is played by the second process. However, this requires further explanation.

According to data [10], an energy of 7 ev is required for the formation' of a p-n pair in crystals of silver halide under the action of electrons. A quantum with wavelength 584 A has an energy of 21.2 ev and is capable to form three p-n pairs at its absorption by microcrystals of the photographic layer. This is confirmed by a series of works [11], in which multiplication of electron excitations in alcaline-halide crystals was observed at their irradiation by vacuum UV-radiation.

Consequently, the number of quanta required for the formation of a stable center of latent image decreases with increase of photon energy. This is why one may assume that latensification by advance irradiation on silver halide crystals will result in a more rapid formation of centers of development at action of more energetic quanta of vacuum UV-radiation. This is corroborated by data brought out in Figs 1 - 3, characterizing the sensitivity variation of the UV-2T film to quanta with energy 21.2 ev (584 A) with the variation of background density, formed by advance irradiation.

The increase of sensitivity to radiation with 584 A at background density 0.1 0.5 should be taken into account in the course of practical utilization of the UV-2T film in the cases when background irradiation of the photolayer is possible.

The investigation of the influence of the background irradtion on the sensitivity of the UV-2T film to higher energy quanta is envisioned.

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