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Sensor based on a non-ideal heterojunction to indicate X-ray images

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Abstract. The sensor of optical image on the basis of non-ideal heterojunctions are investigated in detail. In this work, the opportunity to obtain the image in X-rays was investigated. It is established that investigated sensor is sensitive to soft X-ray radiation. Memory and accumulation of a signal at a room temperature, which is characteristic of the sensor at registration of images in visible light, take place for the images obtained in X-ray range, too, which makes it possible to apply such sensor in medicine and crystallography.

Keywords: sensor, X-ray image, heterojunction.

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Sensors of an optical image based on non-ideal heterojunctions (in particular, CdS-Cu_2S structures) and the principle of their operation have been investigated in detail [1–4]. Meanwhile, it is known that the effect of X-rays, like visible light, leads to appearance of non-equilibrium carriers, and it can be used to obtain images in X-rays. In this case, as in [2,4], image, in fact, should be shaped by non-equilibrium positive charge captured at hole traps in the space charge area of cadmium sulphide. So, there are the reasons to suppose that it shall have the same properties like the images obtained in the visible range of the spectrum. At the same time, it is known that operating sensors of X-ray radiation have the thickness of the sensitive absorbing layer not less than 100 mm. And it should not of forgotten that cadmium as a component absorbs X-rays successfully. But, the thickness of cadmium sulphide layer, obtained by electro-hydro-dynamic spray of liquid, is not more than 10 mm, so the problem to use the given transducer in X-ray range remains open.

To clear up this problem, we use the sample in which the layer of cadmium sulphide was obtained by the above mentioned procedure. A medical facility, giving soft X-ray radiation, was used as a source. The dose obtained by means of this facility was not more than 100 milliroentgen. As the test-subject that partially screened X-ray radiation, used was the absorbing wedge consisted of aluminium foll strips with the thickness of 100 mm each. After an exposure, the sample was scanned, and the shadow of wedge with increasing density being clearly seen on the obtained image. It shows the principal possibility to indicate X-ray images.

Fig. 1 shows the curve for the dependence of photoresponse on the thickness of the absorbing layer d, which is different for various wedge parts. It is seen clearly that the signal value falls exponentially with increasing the absorbing layer thickness. It is seen that the absorbing layer reduces the signal in ratio 1.37. The exponential shape of curve indicates a good linearity for the signal dependence on the dose of X-ray radiation (because an increase of the absorbing layer thickness by the stated value always leads to the same drop in a signal level). It is clearly seen from Fig. 2.

Besides, since the signal being used to construct the plot was taken from different surface points, the obtained curve indicates the sufficient homogeneity of sensitivity to X-rays along the surface.

To investigate the abilities of the sample to be used as sensor of X-ray image, the ordinary IC with standard plastic package was taken. Fig. 3 shows the image of this article obtained in X-rays, with all positive properties characteristic of images obtained in visible rays. As it is seen from Fig. 3, even the traces of the image spread are absent. Under the repeated scanning which was carried out in 30 minutes after the foregoing one, it was found out that in this case there was no spread too, and the quality of the image remained satisfactory, despite the signal relaxation in time. So, the positive properties, such as memory and signal accumulation characteristic of our sensor under image indication in visible beam, take place for the images obtained in X-ray range.

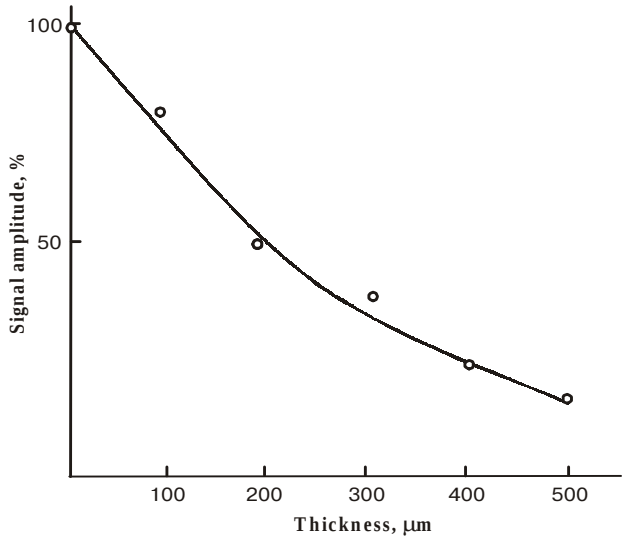

Fig. 1. Dependence of video-signal amplitude on the thickness of absorbing layer.

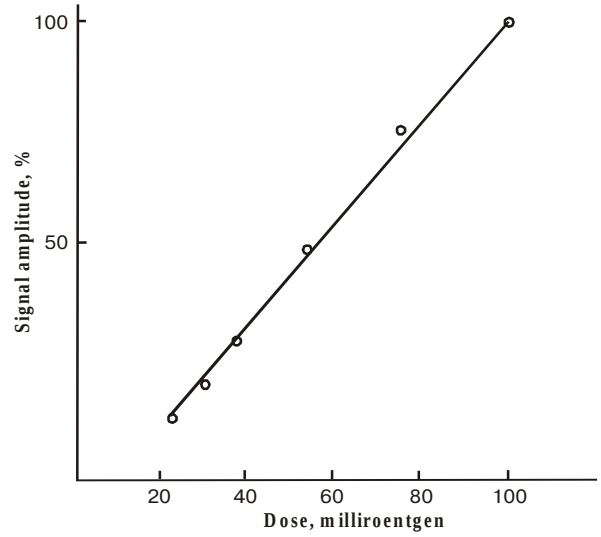

Fig. 2. Dependence of video-signal amplitude on the dose of incident X-ray radiation.

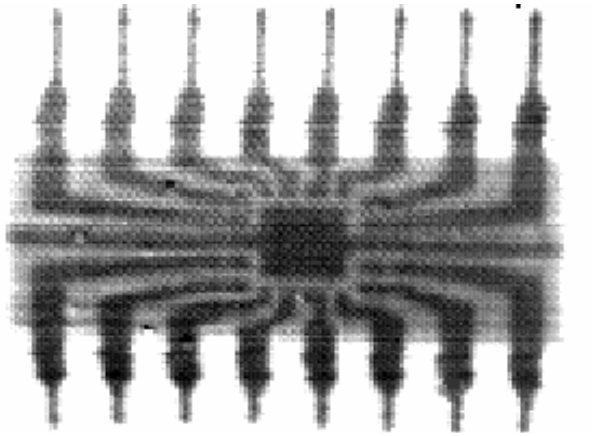

Fig. 3. Image obtained in X-rays using a sensor based on non-ideal heterojunction.

So, being based on the above described investigation, one can say with certainty that our sensor is sensitive to soft X-ray radiation. This makes it possible to use such a sensor in medicine as well as in crystallography.

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