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Receiver For Registration Of X-Ray And Ultraviolet Radiation

Donyorbek Dilshodovich Alijanov
Doctor Of Philosophy In Technical Sciences (PhD), Department Of "Alternative Energy Sources", Andijan Machine-Building Institute, Uzbekistan

Isroiljon Maxammatismoilovich Boltaboyev
Assistant, Department Of "Alternative Energy Sources", Andijan Machine-Building Institute, Uzbekistan

ABSTRACT

A self-contained receiver based on AFS-film (film with abnormal photovoltage) is described, which is hermetically sealed with a reflective hemispherical cover. X-ray or ultraviolet radiation, passing through the photosensitive layer and being reflected from the substrate, falls on the integrating cavity, that is, on the lid, then, reflected from the lid, again falls on the photosensitive layer. In this case, the efficiency of the APV film increases to 50%.

KEYWORDS

Autonomous receiver, APV-film, photosensitive layer, radiation, substrate, optoelectronic, VUP-5K, recorder.

INTRODUCTION

Optical radiation detectors are integral-sensitive receivers, but they can be used to register X-ray and ultraviolet radiation, as primary elements in such recorders. In addition, they are used in optoelectronic and

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robotic devices to receive various radiation fluxes [1-4].

This paper describes a new design of an autonomous X-ray and ultraviolet radiation detector.

Figure 1 shows the structure of an autonomous X-ray and ultraviolet radiation detector, where the designations are applied: 1 - photosensitive layer in the form of an APN-film made of crystalline cadmium telluride; 2 - glass plate, 3 - metal contacts; 4 - reflective coating made of osmium-silicon or osmium-scandium-silicon; 5 - integrating cavity (osmium-silicon or osmium-scandium-silicon); 6 - metal case; 7 - window; 8 - bracket for fastening [5].

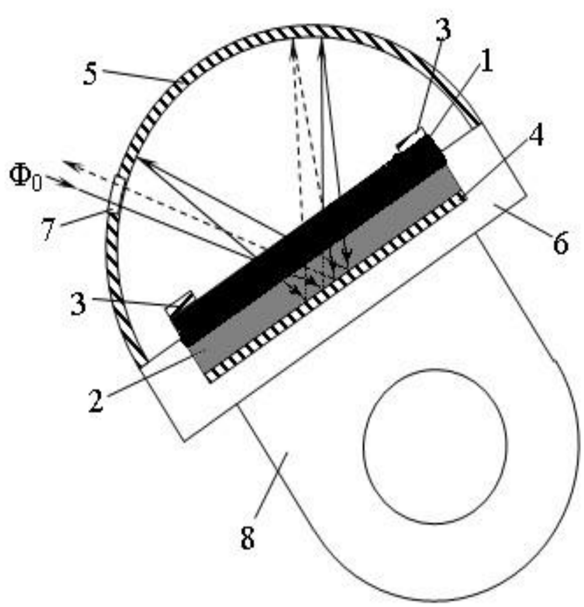

Fig. 1- Receiver for registration of X-ray and ultraviolet radiation

The advantage of this stand-alone X-ray and ultraviolet radiation detector is that it has a much higher sensitivity than other known receivers, so no power source is required for its operation [6,7].

MAIN PART

The developed stand-alone receiver works as follows. Directed monochromatic or other photon radiation from a source, X-ray or ultraviolet radiation enters through the window (7), which, passing through the photosensitive layer (1), is reflected from the osmium-silicon or osmium-scandium-silicon coating (4), falls on the integrating cavity from osmium-silicon or osmium-scandium-silicon (5). Further, this radiation, reflected from the cover, again falls on the photosensitive layer. Due to the repeated passage of layer 1, the radiation is efficiently converted into photovoltage.

It has been experimentally established that in this case the increase in the AFS value is up to 50%.

This result is achieved by the fact that the autonomous receiver of X-ray and ultraviolet radiation is provided with an integrating cavity, i.e. reflective surface of a hemispherical cover made of osmium-silicon or osmium-scandium-silicon, while the receiver body performs two functions: sealing the APV film and providing additional illumination of the photosensitive area. To obtain APV films of reflecting surfaces, a VUP-5K vacuum unit is used. In the working chamber a vacuum of the order of 10-4 –10-5 mm Hg is achieved, the temperature of the substrate is 410 - 470 ° C. Glass plates 4x20 mm in size and 2 ... 5 mm thick are used as substrates. Before starting the process of vacuum evaporation, glass substrates are washed 2-3 times in boiling distilled water for 20-25 minutes and dried in an oven at a temperature of 1600C for 25 minutes, then

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fired at 230-280° C in vacuum for 10 minutes [8.9.10].

Initially, to obtain a reflective layer, a reflective layer of osmium-silicon or osmium-scandium-silicon is deposited on the inner side of the substrate. The spraying process is carried out at a vacuum of 10-4 10-5 mm Hg. Art., substrate temperature 460° C. In this case, the effective thickness of the films is ~ 1 μm.

At the last stage, a reflective hemispherical cover (integrating cavity) is manufactured using the same technology as the reflective substrate. The spraying process is carried out at a vacuum of 10-4 –10-5 mm Hg. Art., at a lid temperature of 460° C. The thickness of the reflective coating is also ~ 1 μm [11].

The X-ray mirror has a multilayer structure (up to several hundred layers); their production requires special conditions. Materials for creating reflective coatings must be of ultra-high purity and are deposited on the mirror base by sputtering in a vacuum. Metals and some chemical compounds are used to create these special layers. The wavelength range in which the mirror will work, and additional conditions and requirements determine the use of certain materials.

The energy ranges of X-ray and gamma radiation overlap in a wide range of energies. Both types of radiation are electromagnetic radiation and, at the same photon energy, are equivalent from the standpoint of the receiver sensitivity. The terminological difference lies in the way of occurrence - X-rays are emitted with the participation of electrons (in atoms, or free), while gamma radiation is emitted in the processes of de-excitation of atomic nuclei. X-ray photons have energies from 100 e V to 250 ke V, which corresponds to radiation with a frequency of 3 × 1016 Hz to 6 × 1019 Hz and a wavelength of 0.005 - 10 nm (there is no generally accepted definition of the lower limit of the X-ray range in the wavelength scale). Soft X-rays have the lowest photon energy and radiation frequency (and longest wavelength), while hard X-rays have the highest photon energy and radiation frequency (and lowest wavelength). Hard X-ray is used primarily for industrial purposes[12].

In the long-wavelength part of the soft X-ray spectrum, osmium-silicon or osmium-scandium-silicon compositions are very effective, and in the harder part of the X-ray spectrum, h APVium and its compositions with other elements are very effective.

Silicon (Si) and quartz (based on silicon dioxide SiO2) materials differ in a different range of optical characteristics required for the optical elements of devices. These natural materials constitute the main raw material for the production of modern optical systems and elements. For example, only silicon cells are capable of refracting X-rays and transmitting infrared rays. Quartz elements transmit ultraviolet rays, rays of the visible spectrum in a wide range and partially refract X-rays In addition, they are distinguished by the invariability of the front of the light wave propagating in the optical material, which, in turn, is associated with the high chemical and physical homogeneity of the material provided by the manufacturing technology [13].

MAIN TECHNICAL CHARACTERISTICS

Radiation wavelength in nm , - 0,005 – 10;

Sensitivity at Jv=1lk, - B5;

Internal resistanceOм 1012-1014;

Response lag timec - (no more) 1;

Durability, h, - (not less) 10000;

Dimensions, mm - 2x6; Weight, g (no more) - 2,0;

CONCLUSION

An important feature of an APV film based on cadmium telluride is its autonomous character. This is of particular interest in film optoelectronics as a radiation converter for ultraviolet and X-ray radiation in a wide range of received electromagnetic radiation.

It is also very important to note the fact that small-sized X-ray mirrors are complex and laborious devices to manufacture, therefore their cost is extremely high.

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