

ON THE SPECTRAL DISTRIBUTION OF THE HIGH-VOLTAGE PHOTOELECTRIC EFFECT IN THIN CdTe LAYERS

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Abstract

Full Text

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ON THE SPECTRAL DISTRIBUTION OF THE HIGH-VOLTAGE PHOTOELECTRIC EFFECT IN THIN CdTe LAYERS

One of the most interesting features of the high-voltage photoelectric effect in CdTe is the inversion of the sign of the photo-emf V_ϕ that occurs when the wavelength of the exciting light is changed. Such an inversion of V_ϕ was described in works ^(1, 2) and was observed in CdTe layers obtained by deposition at angles φ (φ is the angle between the axis of the molecular beam and the normal to the surface) exceeding 25° .

Fig. 1. Curves of the spectral distribution for CdTe samples obtained at $T_p = 340^\circ$ (1), 320° (2), 310° (3), 300° (4), 260° (5), 260° (6), 250° (7), 240° (8), 300° (9)

We investigated the influence of the substrate temperature T_p , onto which CdTe was condensed, on the spectral distribution of the short-circuit current I_3 (see Fig. 1). For all samples $\varphi = 55^\circ$.

It turns out that, with a change in the substrate temperature, the shape of the spectral-distribution curve changes substantially. In samples deposited on the substrate at temperatures of 310° and higher, inversion of the sign of the photo-emf with a change in wavelength in the range $450\text{--}900\text{ m}\mu$ does not occur. In samples deposited at a substrate temperature of $250\text{--}300^\circ$, inversion of the sign of the photo-emf occurs on passing into the short-wavelength region of the spectrum. The lower the substrate temperature, the greater the wavelength at which the sign of the photo-emf changes. The following data illustrate this situation (λ_i is the inversion point):

Fig. 2. Curve of the spectral distribution for a CdTe specimen obtained at $T_p = 240^\circ$ and $\varphi = 20^\circ$

Figure 2: Fig. 2. Curve of the spectral distribution for a CdTe specimen obtained at $T_p = 240^\circ$ and $\varphi = 20^\circ$

$T_p, ^\circ\text{C}$	310	300	260	250	240
Wavelength $\lambda_i, m\mu$	No inversion	460	606	750	900*

* Throughout the wavelength range indicated above, the sign of the photo-emf is opposite to that observed in samples obtained on substrates with temperatures above 310° .

Similar changes in the curves of the spectral distribution for the high-voltage photoelectric effect were observed by E. I. Adirovich and co-workers (2) when the angle φ was changed. According to Adirovich, with a change in φ there is a change in the inversion point λ_i . At small angles (up to 25°) no inversion is observed. At φ greater than 25° , inversion arises in the short-wavelength region of the spectrum. With a further increase in φ , the wavelength λ_i at which the sign inversion occurs also increases. In order to determine which of the factors—the deposition angle φ or the substrate temperature T_p —plays the essential role, the spectral distribution of the short-circuit current of a specimen obtained by depositing CdTe on a substrate at $T_p = 240^\circ$ and angle $\varphi = 20^\circ$ was investigated; under these conditions, according to (1, 2), inversion of the sign of the photo-emf should not occur.

Fig. 2. Curve of the spectral distribution for a CdTe specimen obtained at $T_p = 240^\circ$ and $\varphi = 20^\circ$.

The spectral distribution obtained is shown in Fig. 2. As can be seen, in this case sign inversion is observed. Thus, the principal role in the appearance of sign inversion in the spectral distribution of the high-voltage photoelectric effect in CdTe is played not by the angle of inclination of the molecular beam, but by the substrate temperature. It is possible that the influence of the angle of inclination on the form of the spectral-distribution curve V_ϕ is due to a change in the substrate temperature with changing φ . Indeed, the substrate is partly heated by radiation coming from the evaporator. The larger φ , the greater the fraction of the incident energy that is reflected. The refractive index of CdTe is large ($n \simeq 3$), and the fraction of reflected energy is considerable (at 55° , $\sim 60\%$ of the incident energy is reflected). Thus, with increasing angle the actual temperature of the substrate decreases, which may be the cause of the shift of λ_i .

The shift of λ_i with a change in the substrate temperature that we have found is evidently the cause of the appearance of contradictory data on the photovoltaic

properties of CdTe. Thus, in ⁽²⁾ it is indicated that in different CdTe specimens, in half the specimens a positive sign arises at the thicker end of the layer, while in half the specimens the sign is negative. In ⁽¹⁾ it is indicated that the same sign was observed in all specimens.

We have established that in specimens obtained at $T_p > 310^\circ$, the sign of the photo-emf is the same (positive at the thicker end of the layer). In specimens obtained by deposition at temperatures of $250 \div 300^\circ$, the sign of the photo-emf is different in different specimens.

A similar difference also occurs with respect to the inversion of the sign of the photo-emf when going from illumination from the layer side to illumination from the substrate side. In all specimens obtained at $T_p > 300^\circ$, the sign of the photo-emf under illumination from the substrate side is the same as from the layer side. In specimens obtained at a lower temperature, the signs of the photo-emf under irradiation from the layer side and from the substrate side are different.

From the data presented it follows that the substrate temperature substantially affects the properties of CdTe and, in order to obtain specimens with definite properties, must be strictly maintained.

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CITED LITERATURE

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² E. I. Adirovich, V. M. Rubinov, Yu. M. Yuabov, *Izv. AN UzSSR*, phys.-math. ser., No. 6, 63 (1964).

Note: Figure translations are in progress. See original paper for figures.

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