## *СЕКЦІЯ 2*
## ОПТИЧНІ ТА ОПТИКО-ЕЛЕКТРОННІ ПРИЛАДИ І СИСТЕМИ. ФОТОНІКА

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# EFFICIENCY OF FILM SOLAR ELEMENTS DEPENDING ON THE WORKING TEMPERATURE

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Recently, the development of combined photovoltaic installations, in which thermal energy is utilized during the production of electricity, has actively begun. Photoelectric converters (PhEC), for use in such systems [1, 2], must efficiently generate electrical energy at an operating temperature of 50-55°C; they must also provide a solar energy absorption coefficient of at least 90% and have a reflection coefficient in the infrared part of the spectrum of no more than 10%.

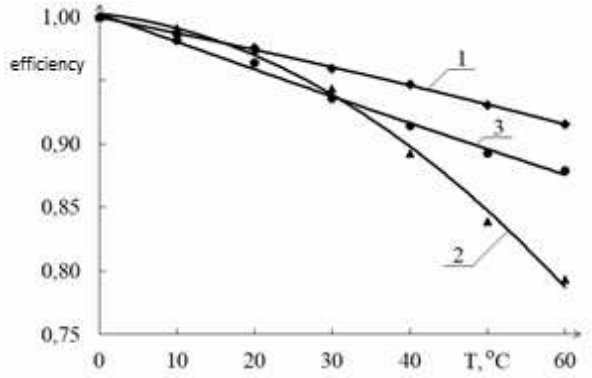


Fig. 1. The relative decrease in the efficiency of film PhECs with an increase in operating temperature: 1 – based on CdTe; 2 – based on $CuInSe_2$; 3 – based on amorphous silicon

A comparison of studies of the temperature dependence of the efficiency of film PhECs based on CdTe and $CuInSe_2$ compounds, produced in laboratory conditions, and amorphous silicon, produced by an industrial method [3], showed (Fig. 1), that the smallest reduction in efficiency when the operating temperature is increased has device designs based on base layers of cadmium telluride.

At the temperature of 50°C, the efficiency decreases by only 1%, and the relative rate of decrease is only 0.14 rel., %/C (Table 1). The experimentally obtained values of the temperature efficiency of single-junction film PhECs are quite accurately correlated with the band gap of the corresponding absorbing semiconductor material (Table), the

temperature efficiency decreases proportionally with the increase in the band gap of the main semiconductor material.

Table. Experimentally obtained coefficients of reduction in the efficiency of film PhECs and the width of the band gap of their basic semiconductor layers

| Based material | Temperature coefficient of efficiency, rel., %/°C | Band gap width of a semiconductor, eV |
|---|---|---|
| CdTe | -0,14 | 1,44 |
| Amorphous Si | -0,21 | 1,2-1,3 |
| $CuInSe_2$ | -0,36 | 1,04-1,07 |

*Keywords*: photoelectric converters, temperature efficiency, semiconductor material, cadmium telluride.

**References**

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[2] V. Perraki, G. Tsolkas, "Temperature dependence on the photovoltaic properties of selected thin-film modules", *International Journal of Renewable and Sustainable Energy*, vol. 2, no. 4, pp. 140-146, 2013.

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## EFFECT OF FAST SWITCHING IN THIN FILMS OF CADMIUM TELLURIDE

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To ensure the protection of electric circuits, protection elements of radio electronic equipment (REA) against impulse overvoltages are used. The most important property of protection elements: gas dischargers, semiconductor zener diodes, varistors and limiting diodes is their ability to reduce their resistance Re from $5 \cdot 10^4$ - $10^{10}$ Ohm to a value significantly lower than the input resistance of the element in a short time $\tau_{sw}$ (switching time or tripping time) REA, when the voltage $U_i$ in the circuit exceeds the value of the threshold voltage $U_t$, which is called the switching threshold or activation