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INFLUENCE OF TECHNOLOGICAL FEATURES ON THE PROPERTIES OF PHOTOELECTRIC TRANSDUCERS

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Technological features of heterostructures SnO_2 | Zn_2O_3 – SiOx – nSi – n+Si are empirically examined, the methodology and modes of their production are analyzed. The technology of production of contact systems Al-Cu-Si is elaborated, their parameters are investigated and their tests are performed. It is proved that the application of such contact systems will increase the efficiency of photoelectric appliances due to simplicity of technological process and cheap materials, that will lead to the reduction of cost price of the product.

Keywords: *solar elements, heterostructures, photoelectric transducer.*

One of the major aims in the engineering of solar elements is increasing their efficiency. [2, 5, 6]. The problem of increasing of PET sensitivity can be solved by means of choosing of heterostructure SNS (semiconductor – nonconductor – semiconductor), that constitutes its fundamentals, and by means of application of high-quality contact systems [1].

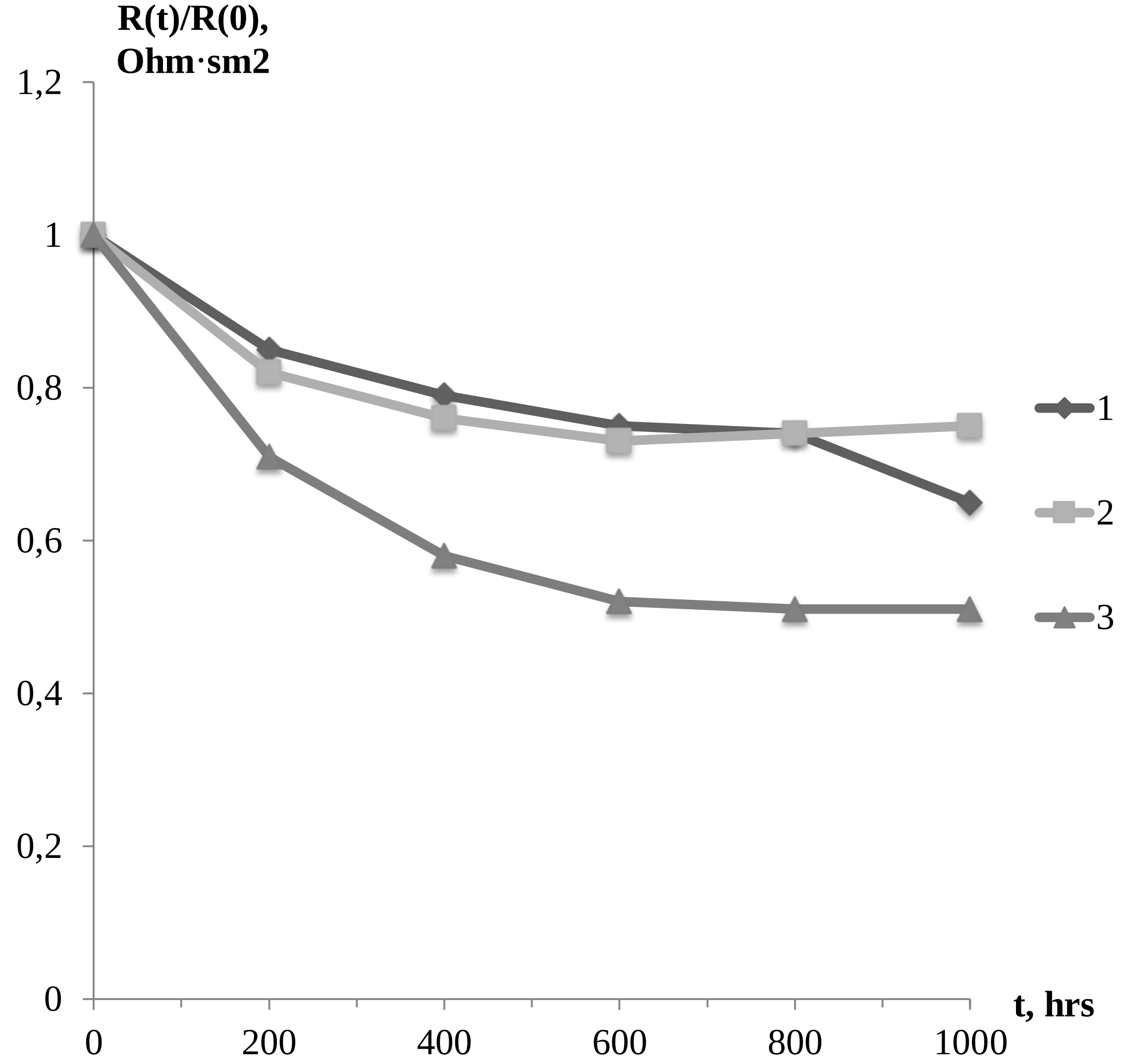
For the production of PET the authors selected the heterostructures SnO_2 | Zn_2O_3 – SiOx – nSi – n+Si, which were made by the method of pulverization of the solution made on silicon epitaxial structure, heated to the temperature of ~ 360ºC – 420ºC. For the sake of keeping the temperature on the level, the plating was performed by means of periodicity of pulverization: 3–6 seconds – spraying, 10–15 seconds – a pause. Pulverization was done with the help of deliberately designed appliance. The function of the pulverizer played a compressed air. The heating of the backing took place with the help of a furnace with smoothly regulated output. The pulverizing lasted till the first blue colour appeared, that corresponded to the thickness of the oxide layer of ~ 80 ^{0}A. The application of hetero-transitions significantly diminishes the expanse of electric energy of PET due to their surface recombination, increase of sensitivity in the "violet" range of the spectrum, where photons' energy is high, and widening of spectrum sensitivity. Besides, the structures of semiconductor- nonconductor – semiconductor type are marked by the simplicity of technology, low-temperature processes required and their high productivity.

Experimentally proved that one of the ways of increasing the efficiency of PET production is the improvement of the technology of contact systems (CS) processing [3, 4].

The authors elaborated the contact system Al-Cu-Si, which is marked by increased stability to electro-migration and which prevents silicon erosion in contact windows simultaneously. The function of the backing was done by silicon plates of nn+ – type with resistivity 0,5-5 Ohm·sm. The plates' diameter was 76 mm, their width - 500 μm.

On corresponding batches of plates the layers of Al, Al-Cu (2%) Al-Cu (2%) – Si (1%) 0,8 μm thick were pulverized. Immediately before the sedimentation the plates were polished in the solution of HF (concentrated) for 30 seconds, after the etching they were washed in a hot and the in a cold distilled water, in alcohol and dried up in the thermostat. After that the plates were put into the camera of the vacuum pulverization device. The interval between the processings and loadings of the camera was 30 minutes. After the formation of the adjusted topology of metallization, the plates were exposed to nitrogen burning with the temperature of 450ºC during 15 minutes and the protective coat of SiO_2 of 0,9 μm thick was applied. It was followed by the oxide removal from the excretive grounds and the splitting into separate crystals was completed. The quality test of instrument structures was held by means of measuring of contact resistance of contact systems. The amount of resistivity ρ for contacts Al-Cu-Si was (0,76-1.52) 10^{-6} Ohm·sm^2.

For quality tests of contact systems the authors investigated the dependence of contact resistance in the temperature of 150ºC. Produced structures were being exposed to this temperature for 1000 hours. The contact resistance was measured after 150, 500, 750 and 1000 hours of exposure. The dependence of normalized contact resistance R(t)/R(0) on the duration of exposure for Al-Cu-Si (graph 1), Al-Cu (graph 2) and Al (graph 3) metallization is provided in the Picture 1.



1 – for Al-Cu-Si;

2 – for Al-Cu;

3 – for Al

Picture 1 — The dependence of normalized contact resistance on the duration of exposure

The analysis of the stability of contact systems before electro-migration demonstrated, that the Al-Cu-Si systems did not prove any refusal either in the process of exposure to the temperature of 150ºC, or in the course of electro-migration tests, whereas for the structures Al and Al-Cu a significant quantity of refuses was observed. Thus, after 1000 hours of exposure to the temperature of 150ºC 2 of 15 Al structures and 2 of 15 Al-Cu structures demonstrated refuses. As a result of electro-migration tests during 256 hours with the temperature of 215ºC there were 14 refusals (with 20 tested structures) for Al and 7 refusals for Al-Cu.

The investigation of the surface morphology of the borderline of metal-silicon, which was estimated by means of scanning with the help of electronic microscope, was completed as well.

In the course of the analysis of Al-Cu-Si structures neither in the process of exposure to the temperature of 150ºC, nor in the course of electro-migration tests, there were no refusals observed, only insignificant amount of silicon precipitate was noticed. For Al and Al-Cu structures a significant amount of refusals and silicon erosion are characteristic.

It is well known, that the value of contact resistance mainly determines the characteristics of photoelectric instrument structures. The variation of the contact resistance points out the necessity of thorough preparation of contact windows before the contact. It was also proved, that cleaning of the backings surface in the processing camera of the vacuum device immediately before the metal coating significantly diminishes the variation of the contact resistance. Minimum value of surface resistivity of Al-Cu-Si with the depth of p-n transition 0, 35 μm was $0{,}76 \cdot 10^{-6}$ $Ohm \cdot sm^2$.

All in all, it is advisable to apply Al-Cu-Si contact systems for a series of photoelectric appliances. Technological processes of the systems obtained do not demand any complicated equipment, the applying of precious metals and require a small amount of operations. The optimal width of the layers in the contact system recommended was approximately 500 ^{0}A.

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