SERIAL RESISTANCE OF THE SOLAR CONVERTER ON THE BASIS OF SILICON WORKING AT THE CONCENTRATED RADIATION

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ABSTRACT

In work it is shown, that serial internal resistance of the solar converter on the basis of solar silicon at the concentrated illumination decreases with to increase intensity of illumination, probable mechanisms of this process are offered.

Keywords: solar converter, efficiency of elements, current of short circuit

I. INTRODUCTION

The photo-electric converters which are carrying out direct transformation of a solar energy in electric on the basis of a semi-conductor photocell, are known enough for a long time. The solar elements intended for work at illumination by concentrated light, concern to a special class of the devices distinguished in many respects from elements, used in usual designs. Now priority works on a way of the further increase of efficiency of the solar photo cells working in conditions of moderate concentration of a solar energy and minimization of cost of system as a single whole are considered /1/.

It is known, that efficiency of transformation is determined as the relation of the maximal target capacity of the device to capacity of radiation falling on it /2/.

$$\eta = \frac{Pm}{Pin} = \frac{FFxIscVoc}{Pin} \qquad (1)$$

where I_{sc}- a current of short circuit
V_{oc} - voltage of idling
FF - the factor of filling

For reception of high values of efficiency it is necessary to maximize all three factors in numerator in the right part of expression (1). Values I_{sc} and V_{oc} and as FF it is determined the whole range of the factors, being today a subject of researches. One of such factors can name presence at real solar elements of serial internal resistance *(Rs)* /3/.

Nature *Rs* is insufficiently investigated and according to /4/ is caused by resistance of thickness of a material from both sides of transition, and also resistance of the obverse contact grid providing gathering and transfer of carriers of a current in loading. The reason of low efficiency is as losses of capacity in a contact grid. Capacity is lost also owing to insufficiently low resistance an alloyed layer, and serial resistance of an element as a whole. There are three components of the serial resistance caused by a contact grid. The first component is connected with a photocurrent in the top layer of the semiconductor between strips of a contact grid. The second represents transitive contact resistance between a metal grid and the semiconductor. The third is caused by resistance of metal strips of a grid. The purpose of the given work is research of features in behaviour *Rs* of a solar element in conditions of repeated concentration of falling light.

II. TECHNOLOGY

The solar element is created on the basis of a silicon plate p-such as conductivity (has been applied so-called solar silicon) by thickness 200 microns and the area of 5 sm^2 with specific resistance ρ=1 Ω x sm. On shaded surfaces p-Si have been created by diffusion of phosphorus n^+ a layer (figure 1). With the purpose of reduction of currents of outflow, and also preservation of a necessary transparency from above n^+ a layer has been put layer SnO_2. As ohm contacts to the obverse and back side has been put *InAl* layer. The obverse contact put stencil in the way, looked like a grid and is structurally designed for operating conditions at the concentrated light.

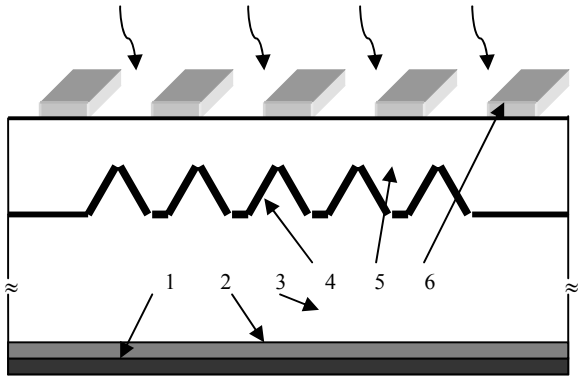

Figure 1. Cross-section section of a solar element.
1,6 - ohm contacted in the basic *InAl*, 2 – p^+ Si, 3 – p – Si,
4 – n^+ - Si, 5 – SnO_2

Table 1. Basics parameters of the solar converter at various lights

E, Vt /m^2	Imax, mA		Vmax,mV		Rs, Ω		t, ^{o}C	
	t = var	t = const	t = var	t = const	t = var	t = const	t = var	t = const
925	190	190	567	590	0,15	0,24	25	15
1850	360	400	580	615	0,11	0,12	31	
3700	790	800	590	631	0,06	0,07	36	
5550	1250	1260	579	645	0,04	0,06	41	
7400	1700	1700	560	650	0,04	0,05	46	
9250	2100	2200	550	652	0,04	0,05	50	

III. PHOTOELECTRIC RESEARCHE:

By us remove characteristics of the solar converter at various falling radiation, since 925Vt/m^2 up to 9250Vt/m^2, measured at various temperatures of system the converter - a substrate. Researched structure located on a radiator with active cooling surface 50 sm^2. The choice of a radiator was any and did not correspond to a mode of full dispersion of heat with preservation stable temperature. Measuring have been lead for same structure also at the stabilized temperature. In table 1 to give the parameters of a photoelement designed from received characteristics are resulted. As a light source has been used the tungsten lamp by electrical power 400Vt. From the table it is visible, that with increase in intensity of an irradiation monotonous growth of a photocurrent is observed. However the voltage of idling grows not monotonously having reached a maximum at light 3700 Vt/m^2, and further decreases, reaching value of voltage smaller than for 925Vt/m^2. Thus with increase of light exposure the temperature of researched structure grows also. Other picture is observed for samples measured at the stabilized temperature. With increase in intensity of an irradiation monotonous growth as current of short circuit, and voltage the idling, aspiring to value diffusion potential.

Such abnormal behaviour of a voltage of idling in the first case is connected with influence of temperature which differently affects the basic characteristics of an element: to average potential barrier, specific resistance of a material of a contact grid and resistance a clarifying covering. Growth and the further reduction of a voltage grow out competing interaction of several processes. In the second case, at the stabilized temperature, monotonous growth of both characteristics is natural for a solar element working at the concentrated irradiation.

In figure 2 to give of dependence *Rs* from irradiation rate for a solar element at changing and constant temperatures, accordingly. On both curves in initial sites it is observed to exhibit reduction *Rs* depending on light exposure. At big light value of consecutive resistance is stabilized. The reason of downturn of value of effective internal serial resistance *Rs* increase of light exposure from 0,24Ω up to 0,04Ω can be caused, in our opinion, by the following probable mechanisms:

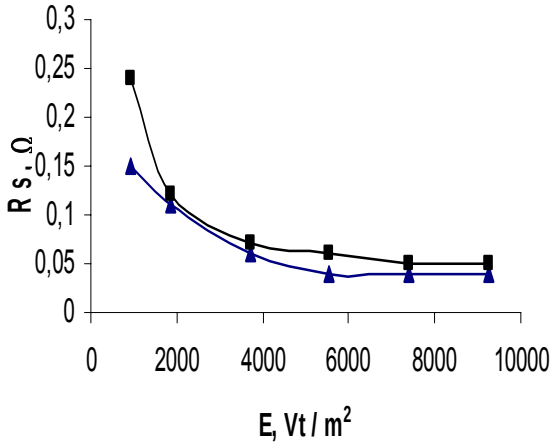

Figure 2. Dependence of serial resistance on intensity of falling light.

IV. CONCLUSION

1. As a result of use stencil method of drawing of a contact grid, between a conducting metal layer and the semiconductor (in our case SnO_2) can arise micro-vials. To increase in light exposure there is a tunneling carrier through these micro-vials and increase of a photocurrent.

2. Besides, as a result of use stencil method of drawing of a grid is probable additional photoemission from a surface of the semiconductor under or near to micro-vials.

3. Saturation recombination the centers of capture - traps carriers at high levels of illumination, reduction of their probability recombination, increases in time of a life, hence, diffusion lengths of carriers and reduction of serial resistance basic areas of a element.

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