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Influence of Functional Ceramic Coatings on Efficiency of Solar Cells

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ABSTRACT:Heating by solar radiation of high concentration allegedly provides for certain advantages. Among them is the purity of the process of heating due to lack of pollution from a heating source, the possibility to carry out technological processes at extremely high temperatures (2500 ÷ 3000^{0}C) by deploying crucibleless technique.Functional ceramic coating significantly increases the efficiency of silicon solar cells.

KEYWORDS: concentrated solar irradiation, silicon photovoltaic devices, functional coating, intrinsic absorption range of silicon.

I. INTRODUCTION

One can improve parameters ofphotoelements by utilizing a part of the solarradiation with the range of energy $h\nu < Eg$ for photogeneration of the current carriers [1, 2]. As is known, asignificant amount (44%) of solar radiation falls at infraread range with λ = 0.75–3 μm. In the existing siliconsolar elements, most of this energy is not used, if photoenergy is transformed into electrical energy.

On the other handin moder solar cells it is frequently impossible to utilize extra photon energy$\Delta E = h\nu - Eg$, which transforms into heat due to thermalization and leads to the heating of photoelements,which weakens their parameters.
Thus, the main pportion of solar radiation in the UV and visible range, where $h\nu > Eg$, is alsonot effectively used and weakens the main parametersof the photoelement, which finally limits the efficiency of silicon photoelements.
In photoenergetics, in order to reduce the effect ofthermalization and increase the absorption coefficientin the UV and visible solar ranges, multicascade photoelements are developed based on $A^{III}B^{V}$ semiconductor compounds.

In our current paper we are reporting the technique of applying functional ceramic coatings on surfaces of various substrates such as on plastic films to cover front surface of silicon photovoltaic devices increases performance of cells.

II. THE MAIN PART

Heating by solar radiation of high concentration allegedly provides for certain advantages. Among them is the purity of the process of heating due to lack of pollution from a heating source, the possibility to carry out technological processes at extremely high temperatures (2500 ÷ 3000^{0}C) by deploying crucibleless technique [1].
By using this technique of heating it's possible to synthesize a whole new class of materials that allows having critical view at many aspects of the existing technological process. Synthesis of materials from the melt in the course of such heating process provides for more promising results as there is no need to overcome the energy barriers of many essential processes, thereby obtaining evenly distribution of components and retain the stoichiometry of the compounds, including at micro level. Moreover, given the fact that synthesis goes on in liquid phase, the synthesis process gets accelerated in hundreds and thousands of times. And also, the process is characterized by the completeness of synthesis.
Based on solar heating technology, we have developed functional ceramic coatings on surfaces of various substrates such as on plastic films to cover front surface of silicon photovoltaic devices (PVC) [2]. This system consists of three layers:

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The first is a polyethylene film with additives, converting the ultraviolet range of solar radiation into visible. This allows not only more efficient use the whole spectral range of sunlight, but also protects the film from photodegradation. The second layer represents a reinforcement layer and reduces the reverse emission of the visible light transformed by the third layer into IR-radiation. Besides that, it is an additional insulating layer.

The thirdlayer contains two types of functional ceramics. The first type of ceramics absorbs solar energy in a wide spectral range and transforms it into infrared radiation with a maximum of 3.3 micron [3]. Besides that, it tends to function as additional insulating layer.

The study evidences that application of functional ceramic coatings at low ambient temperatures provides for a higher temperature value in compare to ordinary films by 5 - 11 degrees, whereas at relatively high ambient temperatures, on the contrary, it ensures lower temperatures down by 9-14 degrees (Fig. 1)

Trial tests of such films with functional ceramic coatings by applying using special technique and measurement instrumentation were conducted. Temperature value in the unit with pure plastic film and functional unit with embedded three-layered ceramic coating are given in Table 1.

Table 1. Temperature value in the unit with pure plastic film and functional unit with embedded three-layered ceramic coating

$T_{average,}$ ^{0}C	-5	+5	+15	+20	+25	+30	+35	+38
ΔT	8	9	11	4	1	-6	-10	-14

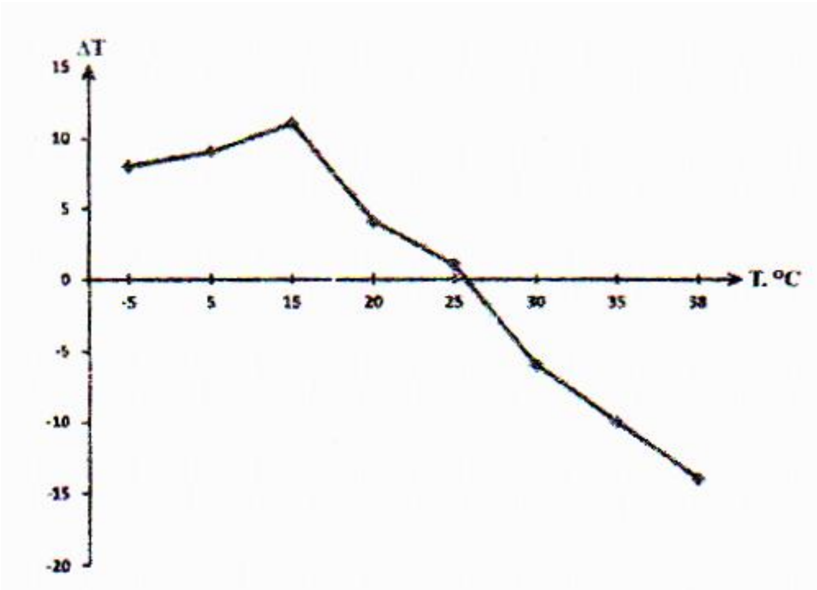

Fig. 1.Temperature differenceΔT in the unit with pure plastic film and functional unit with embedded three-layered ceramic coating depending on ambient temperature T.

Δ T = T1 - T2, wherein T1 - temperature under ordinary film, T2 - temperature under film-ceramic composite.

As follows from the data presented on Fig. 1,in the beginning we observe higher temperature under composite film with functional ceramic coating, and then, at temperature of 15^{0}C we observe bend. At ambient temperature of 25 - 27 ^{0}C, temperature under film with the functional ceramic coating and the reference film become equal. By further increasing the ambient temperature, we witness lower temperature due functional ceramic coating factor. Thus, the functional ceramic coating based on functional ceramics can to a certain degree stabilize the temperature.

To study the effect of the functional ceramic coating on the conversion efficiency of solar energy into electrical energy, photovoltaic panels used on the basis of silicon (effective area of 66 cm^2, consisting of 20 serially connected elements EMF at 35 ^{0}C- 11 V). Measurements were carried out at different modes, sometimes the operating surface of the photovoltaic panelused to be covered by regular glass or by plastic with functional ceramic coating.

It should be emphasized that the use of such functional ceramic coatings tends to increase the current generated by solar cells by 15-20%. This is due to the lower temperatures, and the transformation of the spectrum of solar radiation in the range in the area of self-absorption silicon solar cell, alike.

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Our next task was to design such systems thatwould absorb maximum energy of solar radiation due to conversion of solar spectrum by transforming spectral rangeto harness the fundamental intrinsic absorption range of silicon. This would make it possible not only to make better use of solar energy, especially low intensity, but also would have made cost-effective production of relatively cheap solar cells feasible [4].

III. CONCLUSION

Thus, it was shown that the functional ceramic coating significantly increases the efficiency of silicon solar cells. However, the use of polyethylene film with functional ceramic coating would be an irrational decision, since the plastic film quickly grows old and becomes obsolete. It is therefore necessary to focus on designing transparent coatings on substrates that would have comparatively long lifetime and be irradiation and heat-resistant.

REFERENCES

[1]. Muminov, R.A., Mavlyanov, A.Sh., andTursunkulov, O.M., Influence of the conductivity typeof silicon on the process of radiation degradation ofsolar cells, *Appl. Solar Energy*, 2013, vol. 49, no. 2,p. 62.
[2]. Bakhadyrkhanov, M.K., Isamov, S.B., Iliev, Kh.M.,Tachilin, S.A., et al., Silicon_based photocells ofenhanced spectral sensitivity with nanosized gradedband gap structures *Appl. Solar Energy*, 2014, vol. 50,no. 2, p. 61.
[3]. Игумнов В.Н., Основы высокотемпературной криоэлектроники:учебное пособие, М.-Берлин: Директ-Медиа, 2014
[4]. Р.Х.Рахимов, В.П.Ермаков, М.Р.Рахимов. Гелиотехника. 2010. № 1, с.59-62.
[5].Рахимов Р.Х., Евразийский патент № 001874 дата регистрации 22.10.2001. Керамический материал испускающий инфракрасное излучение.
[6] Рахимов Р.Х., Ермаков В.П. “Функциональная керамика – что это такое?” Изд. «Фарғона» 2007.