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ENHANCING THE OPTICAL PROPERTIES OF BIFACIAL SOLAR CELL

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Аннотация. В последние годы среди возобновляемых источников энергии широкое распространение получили солнечные энергетические установки. В частности, перспективным считается использование тепловых и электрических свойств солнечной энергии. Солнечные панели используются для преобразования солнечной энергии в электрическую. Солнечные панели состоят из небольших солнечных элементов. Солнечные элементы имеют оптические, электрические и тепловые потери. Данная исследовательская работа посвящена улучшению оптических свойств солнечных элементов. В данной работе исследования проводились с использованием двухстороннего чувствительного солнечного элемента.

Ключевые слова: кремний, Sentaurus TCAD, оптический слой, двусторонний солнечный элемент, текстура, планарный солнечный элемент, оптические и электрические потери.

Аннотация. Акыркы жылдары күн энергиясы системалары кайра жаралуучу энергия булактарынын арасында кеңири таралды. Атап айтканда, күн энергиясынын жылуулук жана электрдик касиеттерин пайдалануу келечектүү болуп эсептелет. Күн батареялары күн энергиясын электр энергиясына айландыруу үчүн колдонулат. Күн панелдери кичинекей күн батареяларынан турат. Күн батареялары оптикалык, электрдик жана жылуулук жоготууларга дуушар болушат. Бул изилдөө долбоору күн батареяларынын оптикалык касиеттерин жакшыртууга багытталган. Изилдөө эки тараптуу сезүүчү күн батареясынын жардамы менен жүргүзүлгөн.

Ачкыч сөздөр: кремний, Sentaurus TCAD, оптикалык катмар, эки беттик күн батареясы, текстура, планардык күн батареясы, оптикалык жана электрдик жоготуулар.

Abstract. In recent years, solar energy devices have been widely introduced among renewable energy sources. In particular, the use of thermal and electrical properties of solar energy is considered promising. Solar panels are used to convert solar energy into electrical energy. Solar panels are made up of small solar cells. Solar cells have optical, electrical and thermal losses. This research work is devoted to improving the optical properties of solar cells. In this research work, studies were conducted using a double-sided sensitive solar cell.

Key words: Silicon, Sentaurus TCAD, optical layer, bifacial solar cell, texture, planar solar cell, optical and electrical losses.

Introduction

The production of silicon-based planar solar cells has been studied by scientists around the world for a long time. Among them, Thomas J, Watson Sr and G Araujo and other scientists studied the J_{sc}, U_{oc}, η and μ of solar cells [1]. The study of all solar cells through experimental and modeling has recently come into being, these programming packages have been used to determine various parameters of solar cells. In particular, the parameters determined by Silvaco TCAD software were compared with experimental results and this gave positive results [2]. It can be seen that the calculations using the model created using the Sentaurus TCAD program overlap with the experimental results [3]. Using the Sentaurus TCAD program, contact materials and contact location algorithms for several types of solar cells were developed and positive results were shown. They determined the types of p-n junctions in them and how the density and thickness of charge carriers change [5]. In our study, simulation calculations were performed by modeling a double-sensitive solar cell. This is because it is important to study ways to improve the efficiency of solar cells and reduce their cost. The cost of solar cells has decreased by about 50% between 2011 and 2013 [4]. Therefore, we have determined the dependence of the optical properties of a double-sided light-sensitive solar cell on several parameters by modeling it. A double-sided light-sensitive solar cell receives light from both the front and back sides. Its contacts are arranged in a narrow shape to ensure light transmission. Based on the above considerations, we aimed to conduct research on a bifacial solar cell.

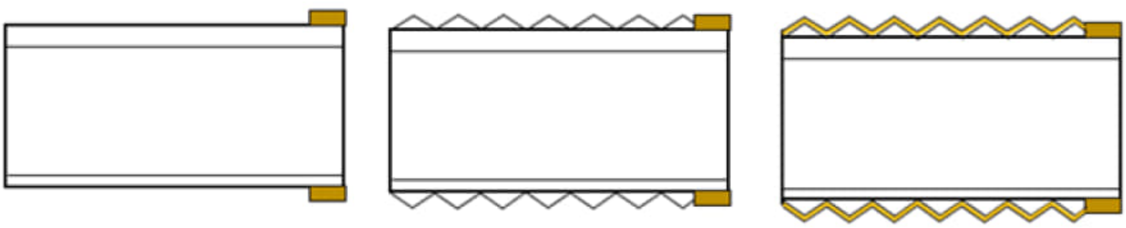
Material and methods

We conducted the following experiment on the double-sided sensitive solar cell under normal conditions. At the beginning of the experiment, the front, back, and both surfaces were exposed to the normal light of AM1.5g sunlight. The following geometric structure was selected for this type of double-sided sensitive solar cell. The geometric parameters of a bifacial light-sensitive solar cell are given in Table 1 below.

1-table

	Width, μm	*Thickness, μm*	*Materials type*	*Doping type*	*Input concentration*
n^+	*20*	*1*	*Silicon*	*Phosphorus*	*10^{17}*
p		*18*		*Boron*	*10^{15}*
p^+		*1*		*Boron*	*10^{16}*

Based on the dimensions of this geometric shape, the geometric shapes of a double-sided sensitive solar cell with a planar, textured, and anti-reflective layer coated on the textured surface layer are presented below.



a) b) c)

Figure 1. Geometric shapes of a double-sided sensitive a) planar, b) textured and c) textured and anti-reflective coated solar cell.

The photoelectric properties under the influence of the front light have been determined for each of the three types of solar cells mentioned above. The determination of the photoelectric properties is achieved through the I-V characteristic.

Results and discussions

The front light effect was shown on this solar cell and the measurement results were obtained several times. The measurement results were performed using the Sentaurus TCAD program using the modeling method. According to this, the front AM1.5G light spectrum was shown on a simple double-sided sensitive solar cell. After that, the front light effect was shown for the shape with a texture formed without a reflective layer. At the end of the experiment, calculations were performed for a sample with a texture formed and an anti-reflective layer SiO2 material coated on the surface layer.

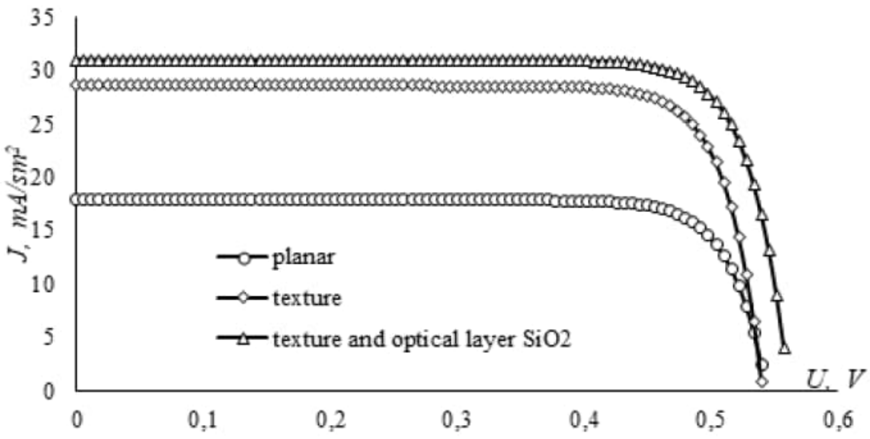


Figure 2. VAX of different structures of double-sided sensitive solar cells under forward light.

According to this graph, the current density generated by the simple planar double-sided sensitive solar cell is 17.87 mA/cm2, 28.56 mA/cm2 for the textured solar cell, and 30.95 mA/cm2 for the textured and anti-reflection layer coated sample on the surface layer. The results show that the simple planar double-sided sensitive solar cell absorbs light in parts far from the p-n junction when receiving light. In the textured solar cell, the light hits the textured surfaces several times, which leads to more light absorption in the surface layer.

Conclusions

This research work aims to improve the optical properties of dual-sensitized solar cells. Accordingly, the following quantities were determined and measured for the planar, textured, and textured surface of the solar cell with an optical layer coated on it. The combined use of the texture and the optical layer significantly increases the light absorption by many times. SiO2 is selected as the optical layer material and is coated with a thickness of 100 nm, which has many applications. The results show that surface treatment is recommended to increase the light absorption properties of a bifacial solar cell. It is advisable to create irregularities in the surface layers and apply a multi-layer anti-reflection coating. In addition, the uniformity of the resulting texture and the multiple layers of optical layers applied to its surface layer prove to be highly effective.

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