DETERMINATION OF OPTICAL PROPERTIES OF AMORPHOUS SILICON BASED SOLAR ELEMENTS USING PV LIGHT HOUSE ONLINE SOFTWARE

Mamatova Go'zaloy Jo'ramirzayevna
Andijan State Pedagogical Institut, physics teacher, Department of Informatics and Exact Sciences

https://doi.org/10.5281/zenodo.7125768

Abstract. *In this article, the photogeneration coefficient increases when the thickness of the base of an amorphous silicon-based solar cell increases, and in which range of light wavelengths the absorption coefficient is good.*

Keywords: *PV Light House, amorphous silicon, solar cell, photogeneration coefficient, light wavelength, recombination level.*

ОПРЕДЕЛЕНИЕ ОПТИЧЕСКИХ СВОЙСТВ СОЛНЕЧНЫХ ЭЛЕМЕНТОВ НА ОСНОВЕ АМОРФНОГО КРЕМНИЯ С ИСПОЛЬЗОВАНИЕМ ОНЛАЙН ПРОГРАММЫ PV LIGHT HOUSE

Аннотация. *В этой статье коэффициент фотогенерации увеличивается, когда увеличивается толщина основания солнечного элемента на основе аморфного кремния, и в каком диапазоне длин волн света коэффициент поглощения хороший.*

Ключевые слова: *PV Light House, аморфный кремний, солнечный элемент, коэффициент фотогенерации, длина волны света, уровень рекомбинации.*

INTRODUCTION

The main advantage of amorphous silicon-based solar cells is that they have a high absorption coefficient. In addition, amorphous silicon, like other amorphous materials, is flexible. Therefore, amorphous silicon is used in the industry for the production of flexible solar cells.

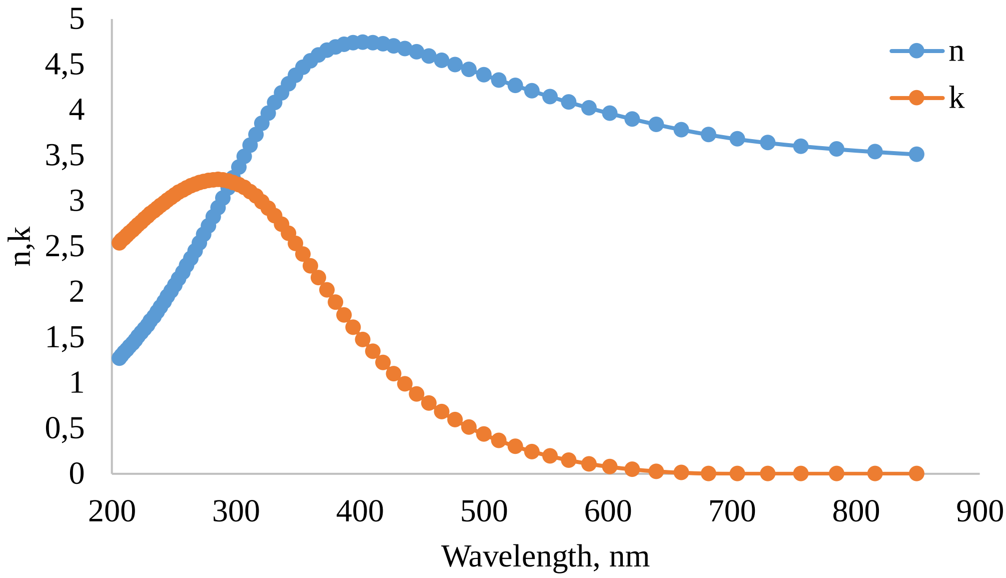
MATERIALS AND METHODS

But amorphous silicon has its own disadvantages. One such drawback is that amorphous silicon-based solar cells degrade over time when exposed to light for a long time. This phenomenon entered science under the name of Stabler-Wronski effect. The essence of the Stabler-Wronski effect is explained by the displacement of hydrogen atoms filling the incomplete bonds in silicon when light falls on it. That is, the active areas created due to this unfinished garden are reduced by introducing hydrogen. But when exposed to light for a long time, enough hydrogen atoms break bonds with silicon and form recombination centers. Therefore, amorphous silicon is degraded.

We mainly use the PVLIGHTHOUSE online platform for our scientific research. Because this platform includes the most basic information and programs in the field of photovoltaics. One such important program is Wafer Ray Tracer. In addition, this platform contains a database of the dependence of the complex refractive index of many materials on the wavelength of light. The graph of the dependence of the complex refractive index of amorphous silicon on the wavelength of light obtained from this base is shown in Fig. 1.

Figure 1.

Dependence of the complex refractive index of amorphous silicon on the wavelength of light



n is the real refractive index of amorphous silicon and k is the abstract part of the complex refractive index. The physical meaning of the refractive index is clear to us. That is, when light falls on the border of two media, according to Snell's law, the relationship between the angles of refraction is calculated depending on the refractive index of the media. The absorption coefficient of the material is determined using formula 1 through the abstract part of the complex refractive index [1].

$$a(\lambda) = \frac{4\pi k}{\lambda} \quad (1)$$

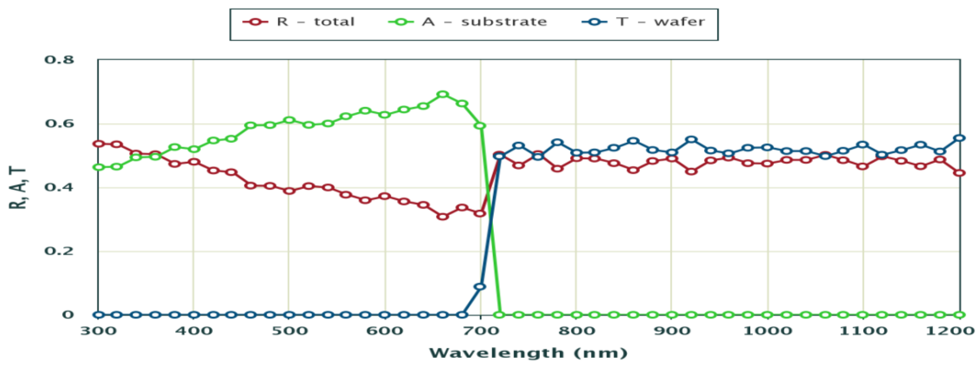
Here: a is the light absorption coefficient of the material, k is the abstract part of the complex refractive index, λ is the wavelength of light.

RESULTS

Amorphous silicon-based solar cells are mainly produced in thin form. Because the recombination rate is high in amorphous silicon. Figure 2 shows the dependence of the optical parameters on the light wavelength of a 5-μm-thick α-Si solar cell determined using Wafer Ray Tracer. Crystalline silicon-based solar cells mainly absorb light in the visible range. Amorphous silicon-based solar cells mainly absorb light in the short wavelength range. Since the band gap of crystalline silicon is 1.12 eV, the band gap of amorphous silicon is 1.52 eV [2]–[3]. That is why the light absorption coefficient of the amorphous silicon-based solar cell decreases sharply at the light wavelength of 700 nm. And the transition and return coefficient increases sharply.

Figure 2

Dependence of the optical parameters of the 5-μm-thick α-Si solar cell on the wavelength of light

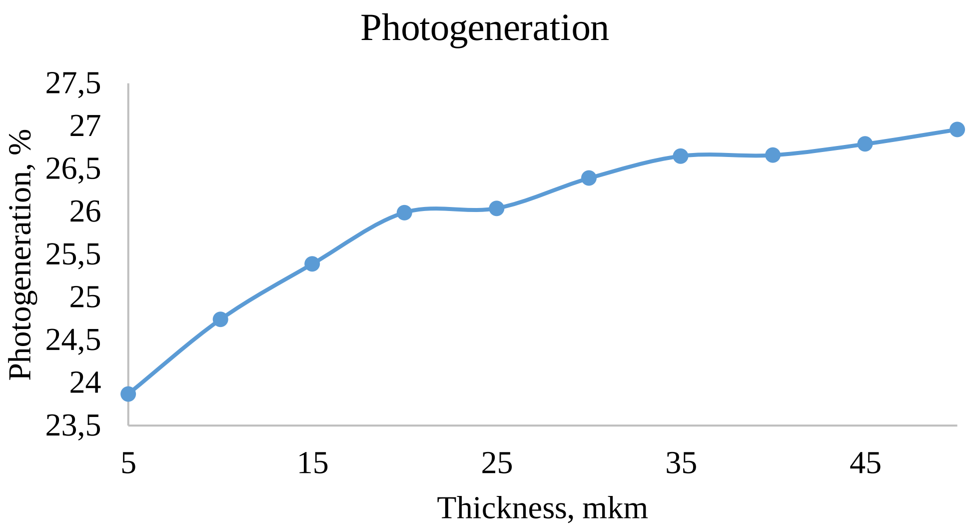


DISCUSSION

Since the abstract part of the complex refractive index of amorphous silicon in the wavelength range of 300-700 nm has a high value, the light transmission coefficient in this range is almost was equal to zero. Therefore, since the amorphous silicon-based solar cell mainly absorbs short-wavelength rays, their thickness does not have to be 170-300 μm, like crystalline silicon-based solar cells. Because short-wavelength light is mainly absorbed on the surface of the solar cell, and their absorption depth is very small. But according to the Burger-Lambert law, it is suggested that light absorption in any layer depends on the thickness of this layer. Therefore, dependence of the photogeneration coefficient of the amorphous silicon-based solar element on its thickness was studied, and the obtained results were graphically depicted in figure 3.

Figure 3.

Dependence of the amount of photogeneration of amorphous silicon on the thickness of the base



CONCLUSIONS

According to the results obtained, when the thickness of the amorphous silicon-based solar element increases by 10 times, the photogeneration coefficient increases only 1.125 times, and the absorption coefficient is good mainly in the range of 300-700 nm of light wavelength. If the relationship between the efficiency and the cost of the solar cell is established, it is preferable to use a thin amorphous silicon-based solar cell.

REFERENCES

1. F. Palmstrom et al., “Optical modeling of wide-bandgap perovskite and perovskite/silicon tandem solar cells using complex refractive indices for arbitrary-bandgap perovskite absorbers,” Optics Express, Vol. 26, Issue 21, pp. 27441-27460, vol. 26, no. 21, pp. 27441–27460, Oct. 2018, doi: 10.1364/OE.26.027441.
2. F. C. Marques, J. Urdanivia, and I. Chambouleyron, “A simple technique to improve crystalline-silicon solar cell efficiency,” Solar Energy Materials and Solar Cells, vol. 52, no. 3–4, pp. 285–292, Apr. 1998, doi: 10.1016/S0927-0248(97)00242-0.
3. K. Sopian, S. L. Cheow, and S. H. Zaidi, “An overview of crystalline silicon solar cell technology: Past, present, and future,” AIP Conference Proceedings, vol. 1877, no. 1, p. 020004, Sep. 2017, doi: 10.1063/1.4999854.