# INFLUENCE OF THE SPECTRUM OF RADIATION ON THE OVERALL EFFICIENCY OF THE PHOTOVOLTAIC CELLS

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**ABSTRACT**: *The influence of the spectrum of solar radiation simulators on the characteristic curve of solar cell was investigated. The spectrum of the radiation sources was determined experimentally. The efficiency of the solar cell and form factor (duty ratio voltage-current characteristic) were calculated. It was found that the electrical characteristics of the solar battery affects spectrum of the light sources*.

**KEY WORDS**: *solar cell, the radiation spectrum, intensity, resistance, capacity.*

## 1. INTRODUCTION

The sunlight is the main source of heat energy for most of the natural processes developing on the Earth's surface, atmosphere and hydrosphere.

The photovoltaic cells effectively convert the solar energy into electricity. The photovoltaic converters of solar energy (photovoltaics, PV panels) are produced as elements with certain surface area, connected consecutively and are called solar panels.

This research studies the influence of the different sources of light energy on the overall efficiency of the photovoltaic cells. Halogen, luminescent (energy-saving), metal-halogen and LED lamps were used to imitate sunlight.

## 2. EXPERIMENTAL PART

The spectrum of the solar simulators was defined with the help of a spectoradiometer SPECBOS 1211UV. The studied object was a poly-crystal photovoltaic cell with dimensions 15x15 cm. The Yanishevsky pyranometer [1] was used to measure the radiation created by the sources of light.

Fig.1 shows the spectral irradiance of the sunlight.

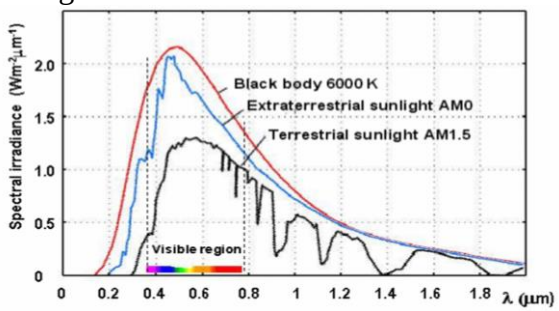



Figure 1. Spectral irradiance of sunlight

Fig. 2 shows the VA characteristics of the photovoltaic cells at irradiance of 200 W/m$^2$.

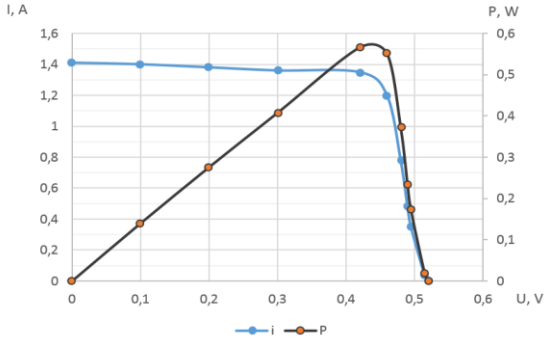



Figure 2. VA characteristics of the photovoltaic cells at irradiance of 200 W/m$^2$

Fig. 3 shows the optimal load resistance depending on the irradiance.

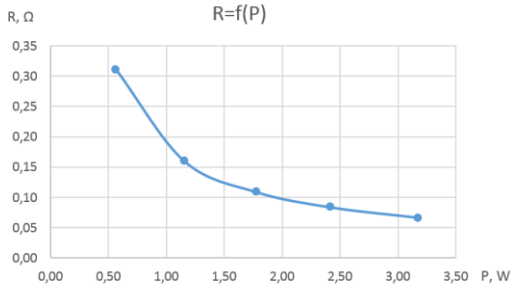



Figure 3. The optimal load resistance depending on the irradiance

The spectral response of the silicon cell is shown on Fig. 4.

It shows that in the area of shortwave radiations this response is quite low due to the upper protective cover – glass [2]. In the longwave radiation zone the response also drops to zero (because of the energy in the "forbidden zone").

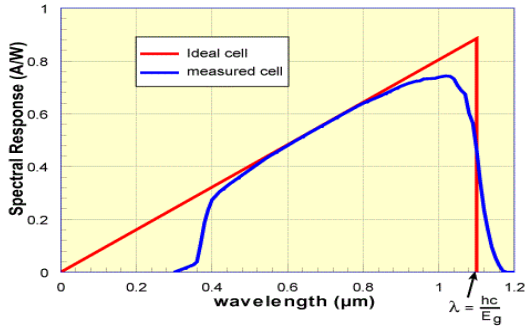
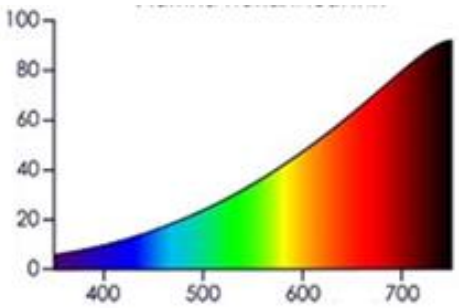
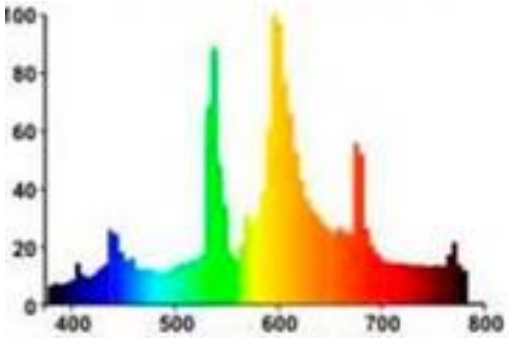


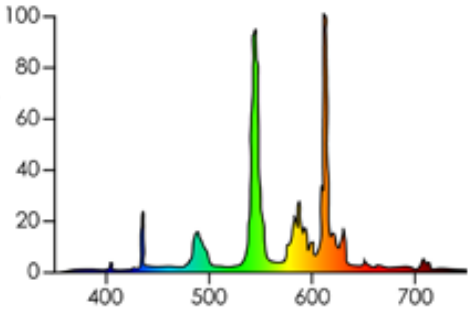

Figure 4. Spectral response of the silicon photovoltaic cell



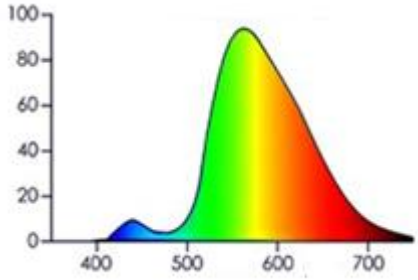
A. Halogen light



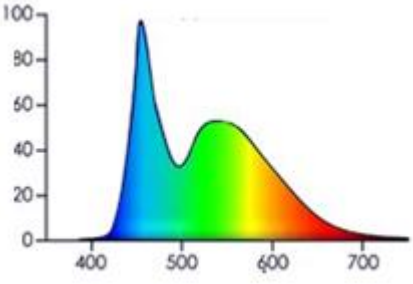
B. Metal halide light



C. luminescent light (energy -saving)



D. light-emitting diode light 3000°K



E. light-emitting diode light 6000°K

Figure 5. Spectrum of radiation of the sources of light

Fig. 5 shows the spectrums of radiation of the used sources of light.

## 3. RESULTS FROM THE EXPERIMENT

The volt ampere characteristics of the photovoltaic cell is tested when illuminating it with different sources [3].

The results are shown in Table 1.

The artificial radiation was one and same during all measurements – 200 W/m2 (according to the data of the pyrometer [4]).

**Table 1.** Measured values of the major parameters of the photovoltaic cell.

| Source | Voltage at no-load condition | Current of the short circuit | Optimal resistance | Maximum power | Overall efficiency | Fill factor |
|---|---|---|---|---|---|---|
| | U, V | I, A | R, Ω | P, W | % | |
| Day light | 0,52 | 1,41 | 0,31 | 0,57 | 12,9 | 0,770 |
| Halogen lamp | 0,43 | 0,90 | 0,39 | 0,29 | 6,4 | 0,748 |
| Luminescent lamp | 0,50 | 0,99 | 0,41 | 0,37 | 8,2 | 0,742 |
| Metal halogen lamp | 0,47 | 1,13 | 0,34 | 0,40 | 8,8 | 0,748 |
| LED lamps 6000°K | 0,52 | 1,40 | 0,30 | 0,55 | 12,1 | 0,753 |
| LED lamps 3000°K | 0,52 | 1,41 | 0,29 | 0,56 | 12,4 | 0,767 |

## ANALYSIS OF THE RESULTS

For halogen lamp

In the spectrum of halogen lamps (Fig. 5A), the rays with wave length of more than 600 nm predominate which leads to heating of the photovoltaic cell and to decreasing of its overall efficiency, respectively. The calculated value of the overall efficiency is one of the lowest – about 6%.

For luminescent lamp

In the spectrum of the luminescent lamp (Fig. 5B), the rays with discrete character predominate (mainly red and green colour). The calculated value of the overall efficiency is about 8%.

For metal halogen lamp

In the spectrum of the metal halogen lamp (Fig. 5C), the rays with discrete character also predominate The calculated value of the overall efficiency is about 9%.

For LED sources of light

The results obtained for the two sources are almost identical:

For LED lamp 3000 K (Fig. 5D), the maximum electrical power is 0.56 W and the overall efficiency is about 12.5%.

For LED lamp 6000 K (Fig. 5E), the maximum electrical power is 0.55 W and the overall efficiency is about 12%.

## CONCLUSION

The study shows strong influence of the spectrum of sunlight imitators on the power of the photovoltaic cells. A determining factor is not the power of the source itself, but the spectral composition of the radiation. The greater the radiation in the visible range, the stronger the photo effect. The presence of radiation in the

longwave area (red rays) significantly reduces the overall efficiency due to the heating of the silicon cell.

## REFERENCES

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