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Spectral effect of a monochromatique light on the performance of a silicon solar cell

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The aim of this work is to show the effect of the wavelength of the incident monochromatic light on the electrical parameters of a silicon solar cell

- 1- Modèle

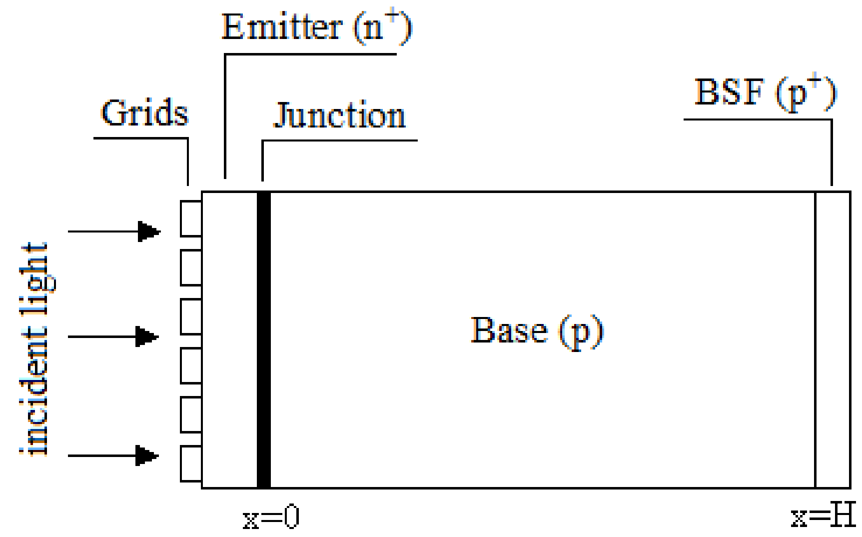

Figure 1: Silicon solar cell illuminated by monochromatic light

- **2- Continuity equation**

$$\frac{\partial^2 \delta(x,\lambda)}{\partial x^2} - \frac{\delta(x,\lambda)}{L_n^{*2}} = -\frac{G(x,\lambda)}{D_n^*} \quad (1)$$

$$G(x,\lambda) = \alpha(\lambda)\phi_0\left[1 - R(\lambda)\right]e^{-\alpha(\lambda)x} \quad (2)$$

$$\delta(x,\lambda) = A_1 \cdot ch\left(\frac{x}{L_n}\right) + A_2 \cdot sh\left(\frac{x}{L_n}\right) - \frac{\alpha(\lambda)\cdot\varphi(\lambda)\cdot\left[1 - R(\lambda)\right]}{D_n\left[\alpha^2(\lambda) - L_n^{-2}\right]}\cdot e^{-\alpha(\lambda)\cdot x} \quad (3)$$

The electrical parameters (current density, voltage, power, output, effeiciency) are obtained by solving the continuity equation

- **Current Density**

$$Jph(\lambda, Sf) = q \cdot D_n \cdot \left.\frac{\partial \delta(x,\lambda,Sf)}{\partial x}\right)_{x=0} \quad (3)$$

- **Voltage**

$$Vph(\lambda, Sf) = V_T \cdot \ln\left(N_B \frac{\delta(x=0,\lambda,Sf)}{n_i^2} + 1 \right) (4)$$

- **Power output**

$$P(\lambda, Sf) = Vph(\lambda, Sf) \cdot Jph(\lambda, Sf) \ (5)$$

- **Efficiency**

$$\eta = \frac{P_m}{P_{ab}} \ (6)$$

$$P_{ab} = \frac{\phi(\lambda)\left[1 - R(\lambda)\right]hc}{\lambda} \ (7)$$

P_{ab} : power of the incident light absorbed by the solar cell

Table 1 : Different colours or light and there corresponding wavelenght [2].

Colour	Wavelength (nm)
Red	622-780
Orange	597-622
Yellow	577-597
Green	492-577
Bleue	455-492
Violet	390-455

The spectrum of solar radiation extends from ultraviolet to infrared including the visible. The frequency ranges from 3.4×10^{16} Hz to 3×10^{11} Hz and the wavelength from 0.01 µm to 1 mm, but photovoltaic conversion takes place only between 0.4 µm and 1.1 µm [1] . The last wavelength range corresponds to the visible and the infrared. The wavelengths of the visible extend from 0.4 µm (violet) to 0.78 µm (red) including the colors of rainbow while the wavelengths of infrared extend from 0.78 µm to 1.1 µm.

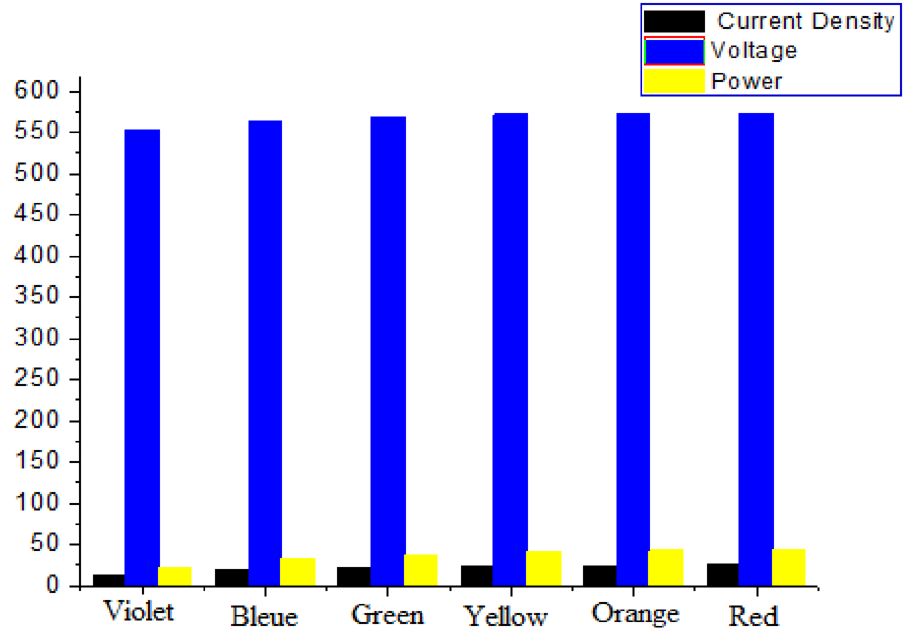

Figure 2: Variation of power, voltage and current density with different colours of monochromatic light

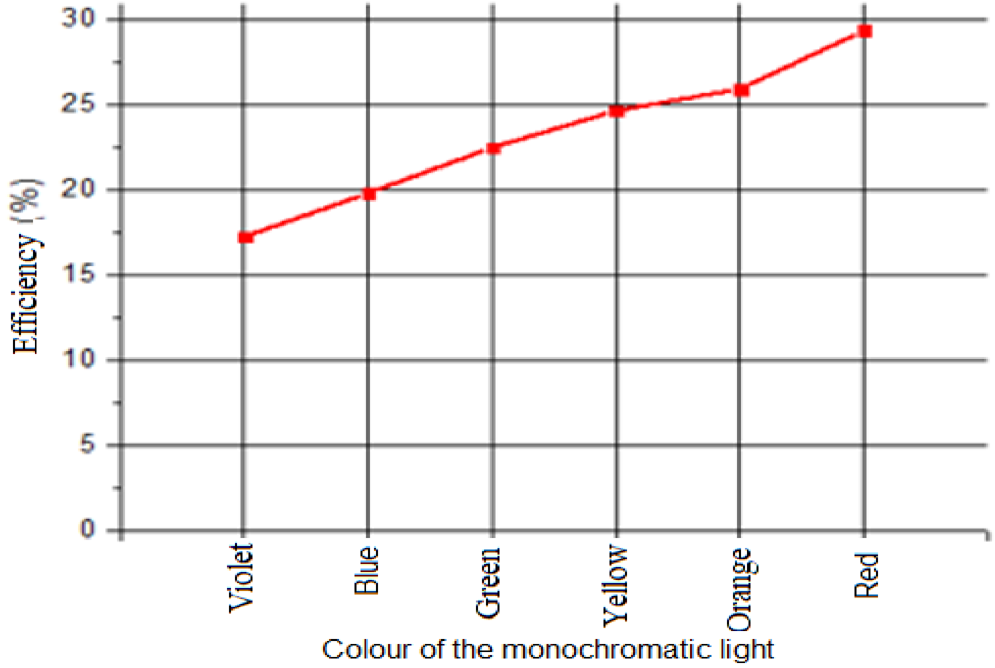

Figure 3:Variation of the efficiency versus of colours monochromatic light

- Results of simulation, using current density- voltage and power- voltage, showed that red colour light generates more electricity than other colours .
- The efficiency of PV cells or panels in general could be improved by exposure to red light as it has been shown experimentaly by Ogherohwo et al. [3]

References

[1] Ouedraogo A, Barandja V D B, Zerbo I, Zoungrana M, Ramde E, Bathiebo D J. Turk. J. Phys., 2017, 41 (4), 288-294, doi: 10.3906/fiz-1703-16.

[2] Neamen D. A. Semiconductor physics and devices: Basic principles. 3rd edition, New York : McGraw-Hill Higher Education, 2003, p. 28.

[3] Ogherohwo E. P, Barnabas. B, Alafiatayo.A.O, IJRCST, July 2015,3(4) , ISSN:2347-5552 .

Acknowledgement

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THANK YOU