A. Curves repeatability

In any system is very important to have the possibility to repeat the measurements with a small error. In the Fig. 7 are shown six measurements of the I-V curve at two different irradiances. As expected, when the irradiance is increased the available power is increased. On the other hand, the comparison of the experimental points of different curves is difficult, but comparing fitting parameters becomes easier. By this reason the exponential fitting of the eq. 4 was realized.

$$I = A_1 \exp\left(-V/t_1\right) + y_0 \qquad (4)$$

The fitted equation of the experimental points is shown with the solid line in Fig. 7. The results of fitting are better for small irradiances. The fitting coefficients A_1, t_1, y_0 and the correlation coefficient r with their error are shown in the Table I. For the great majority of the coefficients its error is less than 1.5%. However, for the coefficient A_1, when $I = 73.04$ W/m^2, its error is ~4.6%.

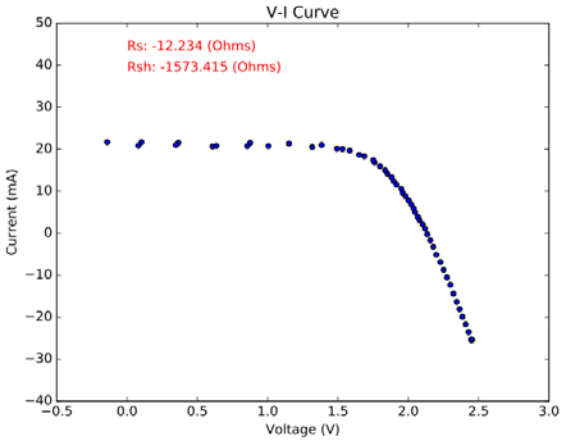

Fig. 8. Curve generated by the Python program

The coefficient y_0 of the fitted curve can be used as an estimation of the short circuit current. A value of $\overline{y_0} = 4.038$ A was obtained when the cell was irradiated with 13.21 W/m^2. At $I = 73.04$ W/m^2 this coefficient was $\overline{y_0} = 23.378$ A. Both values are approximate to the value of current when $V \approx 0$, as it can be seen in the Fig. 7.

C.- Program Output

In the Fig. 8 is shown the plot of the I-V curve generated with the program. As it can be seen from this figure, this time the curve crosses the three quadrants (I, II and IV). Because, the external circuit was employed. Due to this situation the short circuit current and the open circuit voltage can be determined.

An estimation of R_S and R_{SH} was obtained with a linear regression. See eqs. 2 and 3. These values are displayed in the fig. 8. The value of R_S is small and the value of R_{SH} is big. Unfortunately, in different tests these values were changing. Therefore, it is necessary to improve their calculation.

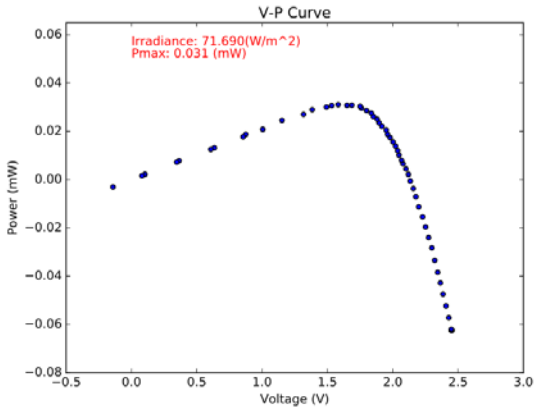

Fig. 9. P-V Curve.

Once that the I-V curve has been measured it is natural to get the power-voltage curve (P-V). In the Fig. 9 is shown this curve. In this plot the maximum power and the irradiance are displayed.

The program also creates two files having the values of the current, the voltages, the irradiance, the shunt resistor and the series resistor.

5. Conclusions

6.

The electrical characteristics of a polycrystalline silicon solar cell was tested under low irradiance conditions with a low cost system.

The system is controlled with Python, which is an open source software.

The measurements can be repeated with a small error.

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