INFLUENCE OF MAGNETIC FIELD ON PHOTOVOTAIC CELLS PERFORMANCE

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Abstract:

This paper investigates the influence of magnetic field on the properties and structure of semiconductors, especially photovoltaic cells. This paper contains description of specific laboratory equipment that is used to create an electromagnetic pulse field. Measurement of electroluminescent radiation was carried out in the research, this measurement pointed to the quality of cells, before the start of the experiment and after its completion. Experimental measurement was carried out on a total of nine samples. Two samples were new, five samples were already worn out, and two samples were mechanically damaged. All these samples were made from polycrystalline silicon (pc-Si). Measurements were performed at the two different intensities of magnetic field.

Keywords: Photovoltaic, semiconductor, solar cell, polycrystalline silicon.

1. INTRODUCTION

This paper describes the influence of magnetic field on the solar cells. The Experimental laboratory equipment is described experiment was performed using this device. All cells were measured before the measurement electroluminescent method. Measurements conducted on nine samples initially as the default measurement and then by effect of the magnetic field. All measurement values were recorded and evaluated.

2. EFFECT OF MAGNETIC FIELD ON THE PHOTOVOLTAIC CELL

The phenomenon of the influence of magnetic field on the solar cells involves several theoretical possibilities. Cell performance can be increased or reduced. For commonly used cells is gradually degrade and therefore it is reducing in power. Lifecycle of the cell is related to the change of performance, there is a possibility that the magnetic field can extend or reduce the life of photovoltaic cell.

The magnetic field is commonly found in the area of photovoltaic power plants and other applied photovoltaic cells. Photovoltaic power plants are exposed to the strongest magnetic fields. Converters have the largest part of the magnetic field, although they are shielded, but still there is a partial magnetic radiation. Other elements are the connecting wires affecting its magnetic field collectors. The power part is the last artificial source of magnetic radiation; it removes energy into distribution network.

3. COMPILATION OF EXPERIMENTAL WORKPLACE

Measuring workplace is composed of several components. The first section is part of the power; it is a pulsed power Helmholtz coil. Regulated auto transformer 0-120 V was used for this power together with rectifier and control unit with end stage. Helmholtz coil itself is the second part, this coil creates an electromagnetic pulse required field. Measuring easel is the third required component on which the samples are fixed. Covering cylinder is the last necessary component that prevents contact with live parts of the coil. It is also used to shielding external undesired electromagnetic waves. Ensuring steady measured cell lighting is an integral part of the shield tube and light source.

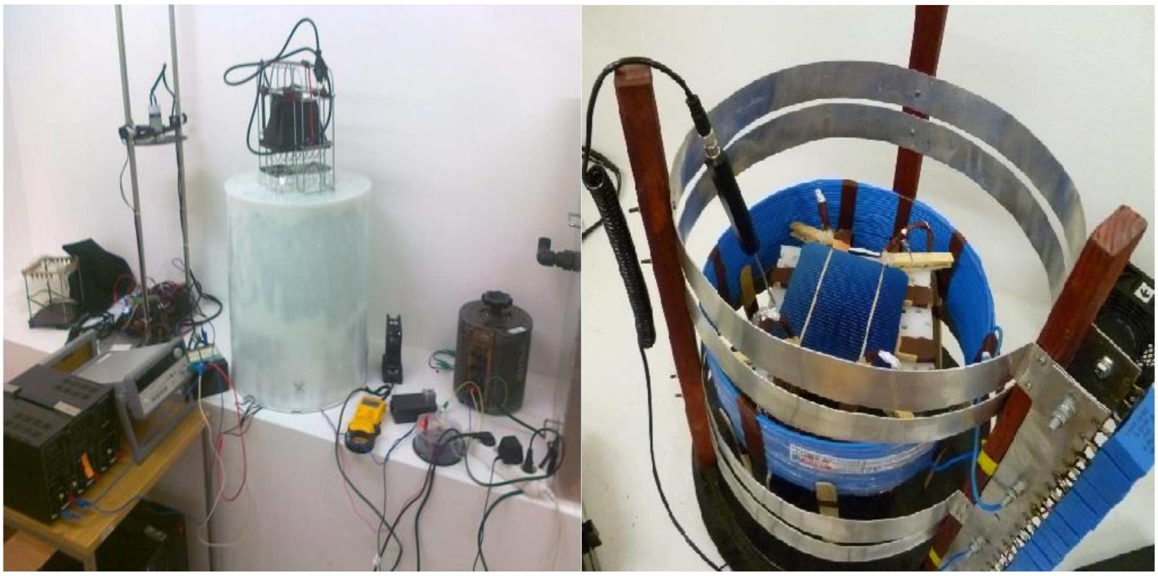

Figure 1: Experimental measuring workplace

4. ELECTROLUMINISCENCE

All samples were tested by using electroluminescence of photovoltaic cells before starting the experimental measurements. Electroluminescent radiation caused by power current in the darkroom. Captured images are used to detect defects in an individual samples. It can specify whether an cell is functional, or it is damaged in any way. This damage is not eye observable and it can affect the measurement.

Images of electroluminescent radiation were taken again after the measurement of influence of the magnetic field on the test cells. In these images, it was examined if the magnetic field did not cause any additional defects.

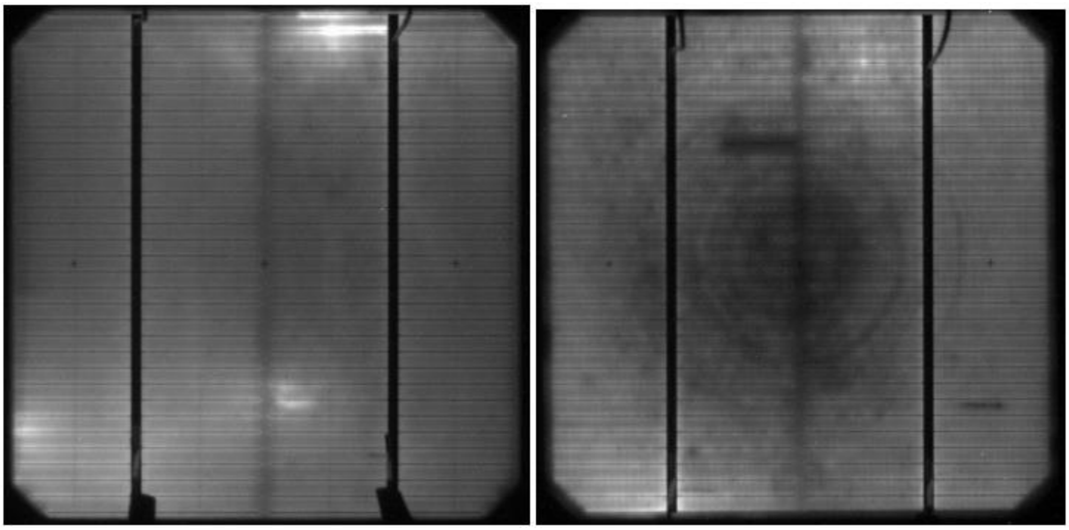

Figure 2: Comparison of new and defective cells using luminescence

5. MEASURING THE EFFECT OF MAGNETIC FIELD ON THE PHOTOVOLTAIC CELLS

Measuring the influence of magnetic field on the solar cells was performed at nine different samples. All measurements were repeated three times at each sample, in order to eliminate errors caused by the measuring method. There was a small insignificant divergence for repeated measurements; it was caused by the temperature change. Comparing the measured values always conducted the same values of temperature to the cell.

Default measurements were performed under normal laboratory conditions without the magnetic field at first. The values measured during effect of the magnetic field at the solar cell were then compared with the measurements. Measurement of the magnetic field takes place at two different intensities. The first measurement was carried out in a low magnetic field with an intensity of 7.76 $x10^{-5}$ T. Samples were subjected to a higher magnetic field with an intensity of 1.8 $x10^{-3}$ T in the second measurement. Measured cells were placed in a magnetic field so that the magnetic field lines entered perpendicularly to the cell.

Any of nine samples did not produce positive changes in V-A characteristics when measuring the magnetic field of intensity 7.76 $x10^{-5}$ T. Therefore, it can be argued that the magnetic field intensity of the order $x10^{-5}$T has no significant effect on the functionality of the photovoltaic cell. The resulting graph is presented for illustrative comparison of the sample number 2.

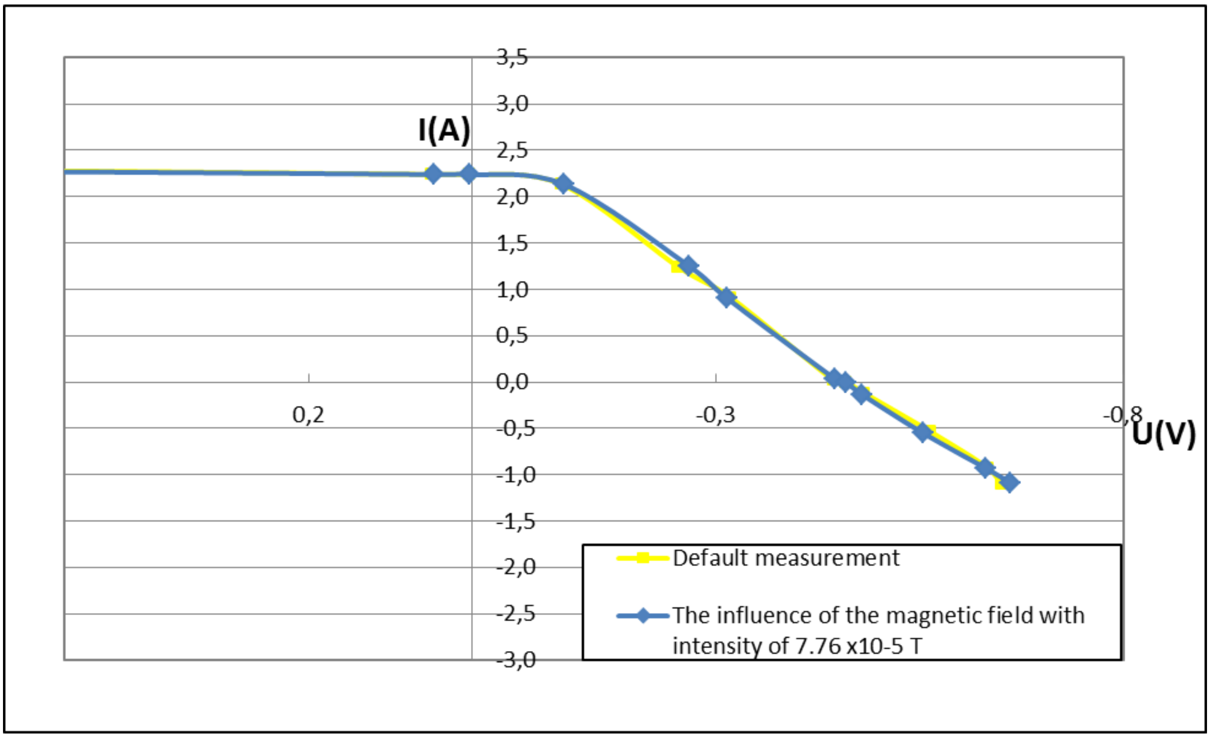

Figure 3: Comparing default measurement and the influence of a low magnetic field at 33 ° C - detail quadrant of the second sample

Measuring the magnetic field of intensity 1.8 $x10^{-3}$ T with perpendicular the field lines entering into the cell had two different results when compared with the initial measurement. Seven of the nine samples showed similar values. It is very clearly visible for the sample number eight. The slight increase in current is apparent when comparing the measured values. This current increase is most likely caused by inducing an electric current in conductive paths of photovoltaic cell.

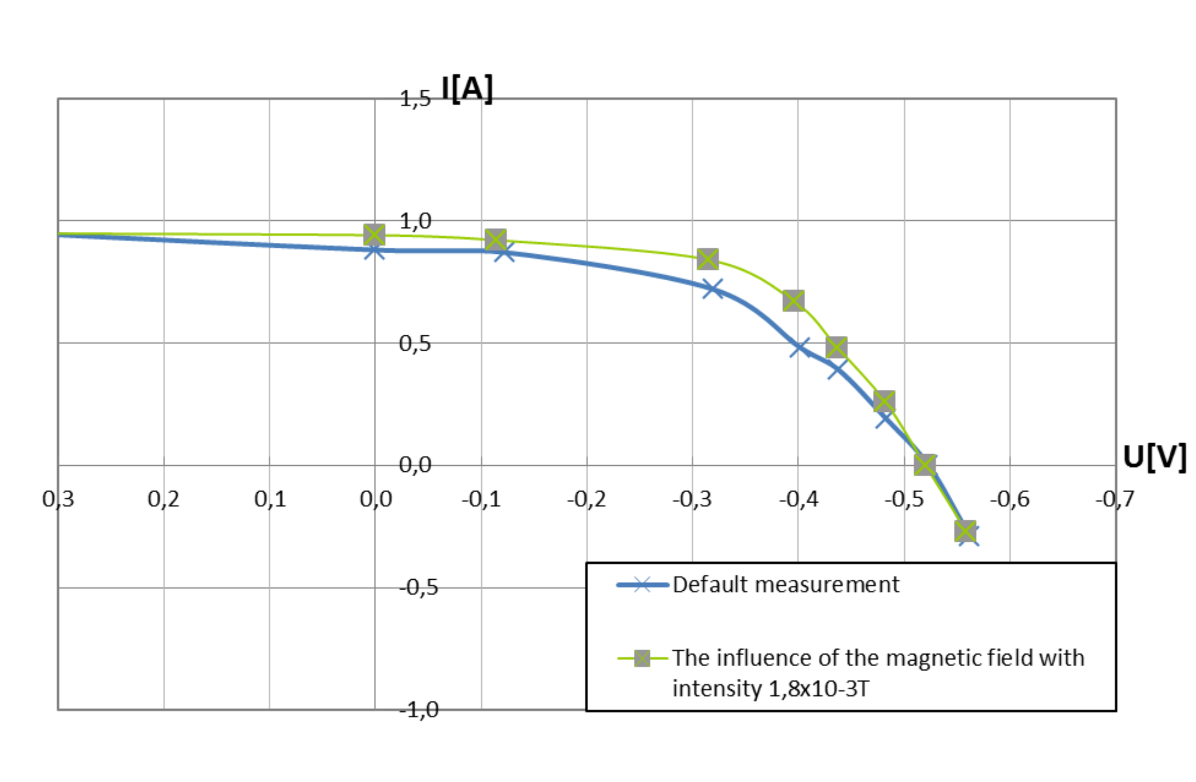

Figure 4: Comparing default measurement and the influence of a strong magnetic field at 33 ° C - detail quadrant the eighth sample

Measurement of the samples number two and five are preserved in the opposite way, compared to the values in the graph pointed to the significant decline in current value of the magnetic field with intensity of 1.8 x10^{-3} T. It was a highly defective cell, which showed electroluminescent radiation. There is probably energy loss of electrons to the defect. For clarity, there is a graph comparing the indicated sample number two.

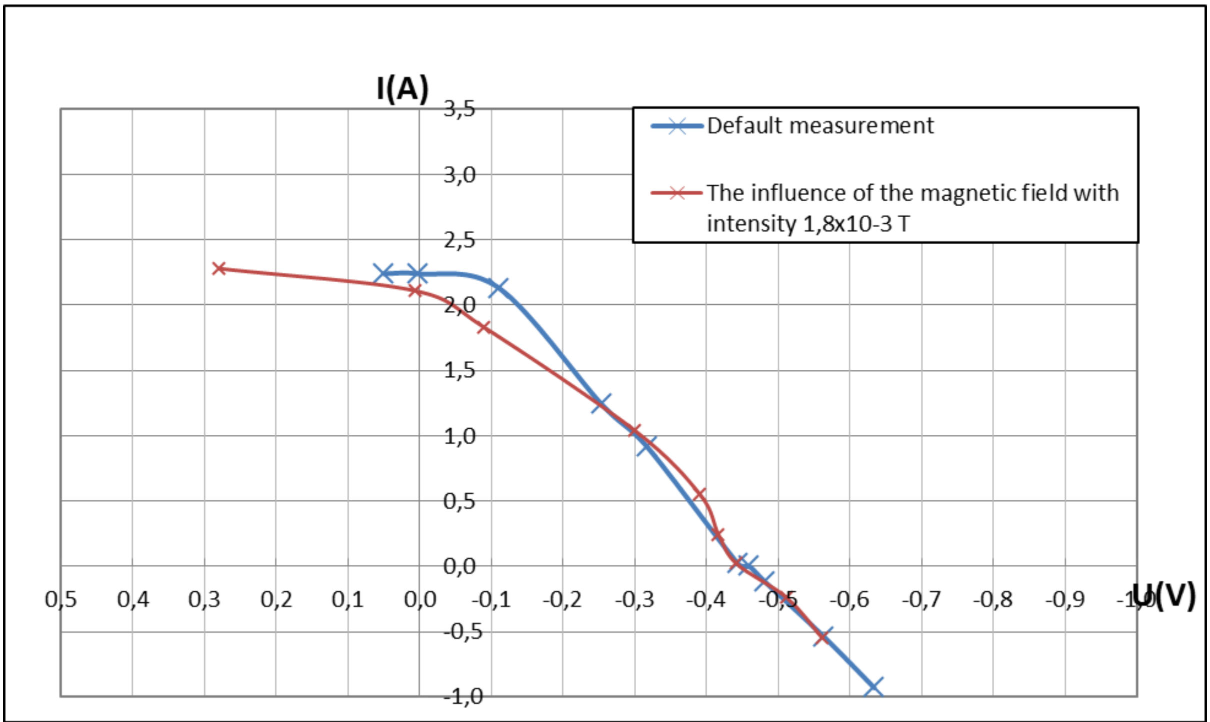

Figure 5: Comparing default measurement and the influence of a strong magnetic field at 33 ° C - detail quadrant the second sample

6. CONCLUSION

This work is devoted to the influence of the magnetic field applied on photovoltaic cells. There is also described an experimental laboratory equipment, implemented with the assistance of the Helmholtz coils with which the experiment was conducted.

Captured images electroluminescent radiation is used to complete idea about the sample. Using this method can be detecting defects arising from the cells that are not visible the unaided eye. All cells were measured using electroluminescent before measurement, it was known that the quality and level of damage. Upon completion of this experiment were measured again by the method to eliminate the possible influence of magnetic field on the structure of the cell. Cells by this method were measured again to exclude the possible influence of magnetic field on the structure of the cell after the end of the experiment. None of the sample after measurement showed other signs of damage.

Low magnetic fields did show some changes in any of the measured samples and after this experiment, we can say that the intensity of the magnetic field around the values of the order 10^{-5} T has no effect on the V-A characteristics of the photovoltaic cell.

High magnetic field with intensity of 1.8×10^{-3} T has two different results. In seven of the nine samples, the results were almost identical for each of them. There was a slight increase in power. Because of these results it can be said that the magnetic field has a positive effect on the V-A characteristics of photovoltaic cells. For a sample number two and five there was a significant decrease in power this decrease was probably caused by cell defects cell.

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