STUDY OF RADIATION FROM LOCAL REGIONS IN PN JUNCTIONS

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ABSTRACT

The microplasma discharges in the PN junction local defect micro-regions are as a rule, accompanied by the emission of light. This radiation from solar cell PN junctions was measured by means of a optical fibre connected to the optical input of a photomultiplier. By inching the fibre by means of computer-controlled X-Y plotter above the cell surface a 2-D image of the irradiation local regions has been created. It is seen that a cell of a superficial area of 100 square cm contains a large number of defects, which depends on applied reverse voltage. This method can be a convenient tool for study and diagnostics of optoelectronic devices.

1. INTRODUCTION

It has been reported by Chynoweth and McKay [1] that the emission of visible light can be observed on small regions on the surface of solar cells. The solar cells have similar features as a PN junction of diodes with a small area of a junction. Local avalanche breakdowns will this take place it the neighborhood of such a defect (microplasma region) at reverse voltages below those required for an avalanche breakdown in a defect-free region of the junction. This noise pulses are grouped in several sets. In the case of solar cells there are many times more sets of light emitting groups.

2. REALIZATION

The working compartment for the light emission flow measuring contains a sensing element, a positioner (trackpoint part) and a processing part. A CCD sensor or a photomultiplier can be used as the sensing element. The main advantage of the photomultiplier is higher sensitivity, only few fotons can be cought. It is necessary to use the photomultiplier with sensitivity as high as possible for mapping the surface of the whole solar cell from the very low source voltage. Otherwise it is not able to read the whole surface in one moment. Therefore a photomultiplier detecting aperture (photomultiplier input) must have an ability to move above the whole surface. This is caused by a positioner. There are two different ways to realize the positioner. Connection of two stepping motors controlled through the digital signals brings better exactitude. In this case there was a possibility to use a modificated analog plotter. The resolution tests showed that the plotter controlling by PC via a 12bit A/D converter is enough strict as is requested for definite focalization the photomultiplier input above the light spot.

The photomultiplier input is not movable itself, by reason of weight and size of a photomultiplier valve, a connection between the photomultiplier input and a plotter shank is realized by an optical fibre. This fibre must have the transfer characteristic as flat as possible. If not, a nonlinear distortion will appear in a transfer line and some of transferring wave lengths will be suppressed. One-aspectual fibres and also many-aspectual fibres are not sufficient, only universal fibres for experimental use and teaching use in school laboratories from plastic have quite flat characteristics. The movable end of the fibre mounted on the plotter shank is 1mm above the solar cell surface.

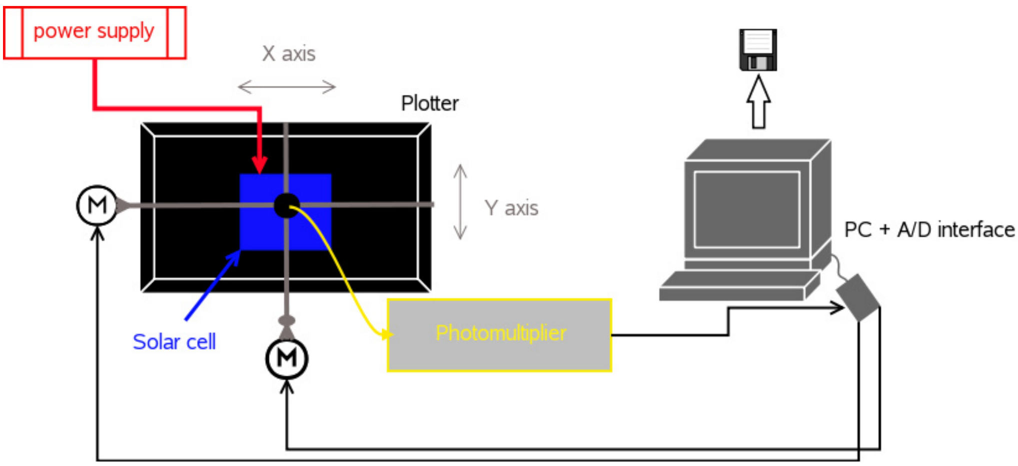

Fig. 1: Workspace order

An output signal from the photomultiplier is coming to the A/D converter input and the oscilloscope input for time behavior illustration. The computing algorithm have enough information about features of a signal coming from the photomultiplier with the 12bit A/D converter resolution. Both motors in the positioner are also controlled with this 12 bit resolution , first for X - axis and second for Y – axis.

3. MEASURING AND COMPUTING ALGORITHM

The position and size of cell must be set before measuring. An user can choose how many steps will be per X – axis and Y – axis. How depends the step with the diameter of a fibre, the distance from a surface and an optical fibre aperture is shown on fig. 2. The number of steps per lip is quotient between size of this lip and the real step which must be calculated from a imaginary diameter.

The measurement consists of the fibre position moving, following rows and columns by zig zag method. Each step contains setting the true position, getting 1000 sample and averiging. The average value is stored into a memory for future data handling.

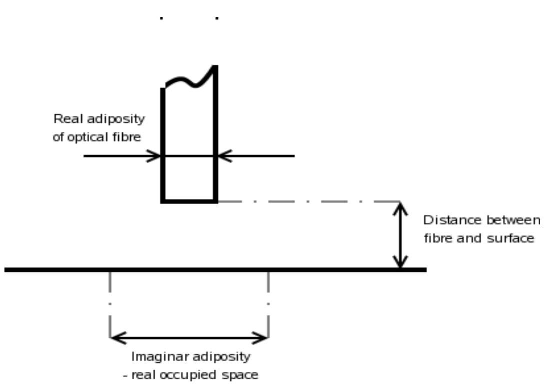

Fig. 2: Real step of fibre

The computing algorithm sorts the data from the lowest value to the highest value and find range of used data. The noise must be removed by the tresholding algorithm part, black color (the darkest shadow) coresponds to the lowest measured value and a white color (the highest light emission) coresponds to the highest measured value. The view of cell can be displayed after setting parameters of drawing,.

4. RESULT DISCUSSION

Figures 3,4,5 show us local regions in the solar cell sample at various source voltage from lower to higher voltage. Every light stands for local defect micro-region. Position of each region is coincidentally placed on the cell surface. Lighter point means higher light emission from a defect region and higher current through this region. If source voltage gets higher, some microplasma regions became active and regions with existing activity produce higher light flow from this time.

Fig. 3: Local areas at 6V reverse voltage

Fig. 4: Local areas at 9V reverse voltage

Fig. 5: Local areas at 12V reverse voltage

5. CONCLUSION

It has been observed that discharges in the PN junction local defect micro-regions are accompanied by the emission of light. This emission of light has been measured by the photomultiplier supplemented by X-Y positioner. The 2-D images of the irradiation local regions for 3 various supply voltage has been showed after the processing by the computing algorithm. A number of local defect micro-regions is increasing and getting more emitting with incrementing value of reverse supply voltage.

ACKNOWLEDGEMENTS

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[2] A. G. Chynoweth and K.G. McKay, Journal of Applied Phys. 30, 11, 1811 (1959)