STUDY OF RADIATION SPECTRUM EMITTED FROM LOCAL REGIONS IN PN JUNCTIONS FEN

Ondřej Krčál
Doctoral Degree Programme (1), FEEC BUT
E-mail: xkrcal04@stud.fit.vutbr.cz

Supervised by: Pavel Koktavý
E-mail: koktavy@feec.vutbr.cz

ABSTRACT

The microplasma discharges in PN junction local defect micro-regions are as a rule accompanied by the emission of light, as it has been reported by Chynoweth and McKay [1]. The emission of visible light can be observed on small regions on the surface of solar cells. This study deals with investigating the spectrum of emission and determines the wavelength with maximum intensity.

1. INTRODUCTION

The radiation from solar cell PN junctions was measured by means of an optical fibre connected to the optical input of a photomultiplier. The optical fibre is divided into two parts, their connection is realized across the removable optical filter. Every optical filter has known characteristics measured by the spectral analyzer. A 2-D image of the irradiation local regions has been created by inching the fibre by means of a computer-controlled X-Y plotter above the cell surface. It is seen that a cell of a superficial area of 100 square cm contains a number of defects, which has similar basic characteristics.

2. PN JUNCION RADIATION STUDY METHOD

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 photons can be caught. 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 accuracy. In this case there was a possibility to use an analogue 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 f 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. Single mode fibres and also multi mode 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. An output signal from the photomultiplier is coming to the A/D converter input and the oscilloscope input for time behaviour illustration. The computing algorithm has 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.

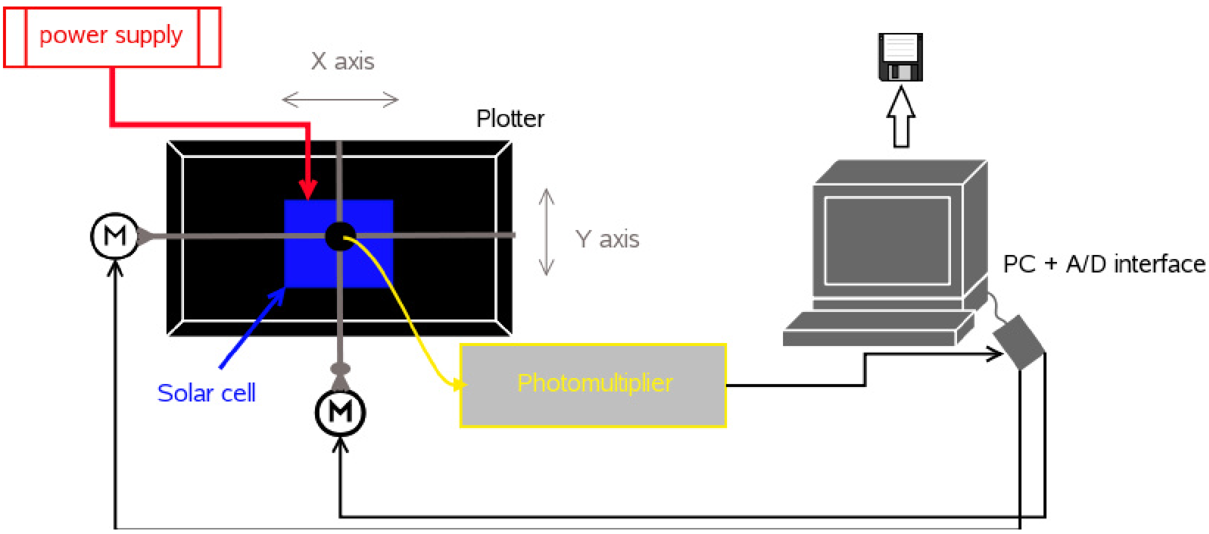

FIGURE 1. Workspace order

3. REALIZATION

One of main goals of emission measuring is to uncover the frequency spectrum, which indicates features of emission that could be obtained with difficulty by the other measurement method. In case of this study is to determine the center of maximum emission wavelength and the spectrum course. As it is known, the emission should be in the visible light spectrum. That is why the filters for the visible light were chosen for the purpose of filtering. The characteristics of filters have been measured by the differential method with using the digital spectral analyzer. Frequency throughputs of filters normalized according the filter with the highest throughput on the central frequency are in figure 2.

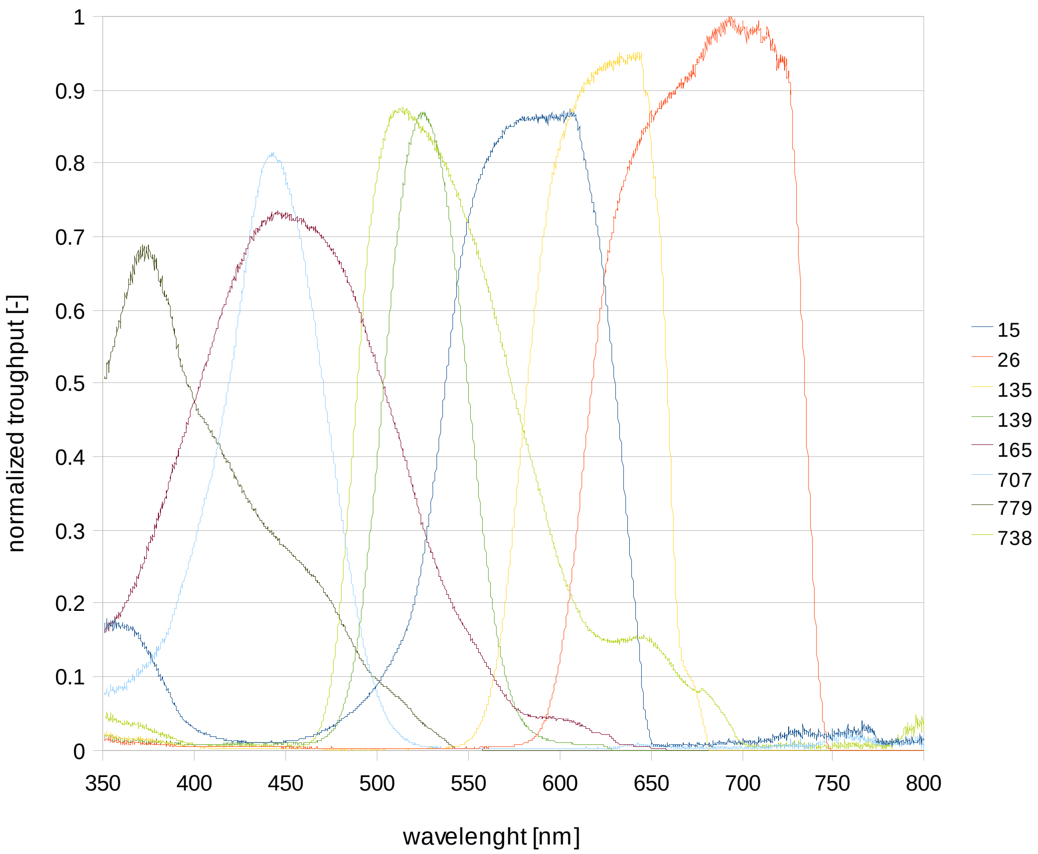

FIGURE 2. Filters throughput characteristics

From know characteristic of filters the frequency construction masks was made by the addition/subtraction algorithm, which handles band overlapping caused by the other near placed filter(s). The indexes of emitted wavelengths for the maximum pass can be easily computed by the construction masks. That is the solution for real time measuring. Frequency construction masks are determined only once that spends a lot of time at the beginning, but index estimation of emitted light for each filter is quick.

The filters are placed between optical fiber and photomultiplier input. The polarization filters were tried for this purpose as they the very narrow band pass. Their unsuitable feature is very high attenuation that is the main reason, why they couldn't be used. The detector – photomultiplier is not able to catch any emission. The used belt filters covers the wavelength from 350 nm to 700 nm. The next figure 3 shows the final emission characteristics. It can be seen the maximum is on the 580 nm wavelength, it is possible to monitor a significant downward trend to the nearly zero-intensity radiation near the maximum frequency. Digressing from maximum it can be observed, the intensity is growing moderately.

The next investigation was focused on the finding out, whether all the emitted local regions have the same or similar spectrum. The number of the emitted regions was determined by the measuring without the filter, than the comparisons with the measuring with the filter have been done. The results show us the spectrum emitted from solar cell surface, its maximum – characteristic wavelength. This information can nearly indicated the micro plasma discharges, what is the main goal of this study.

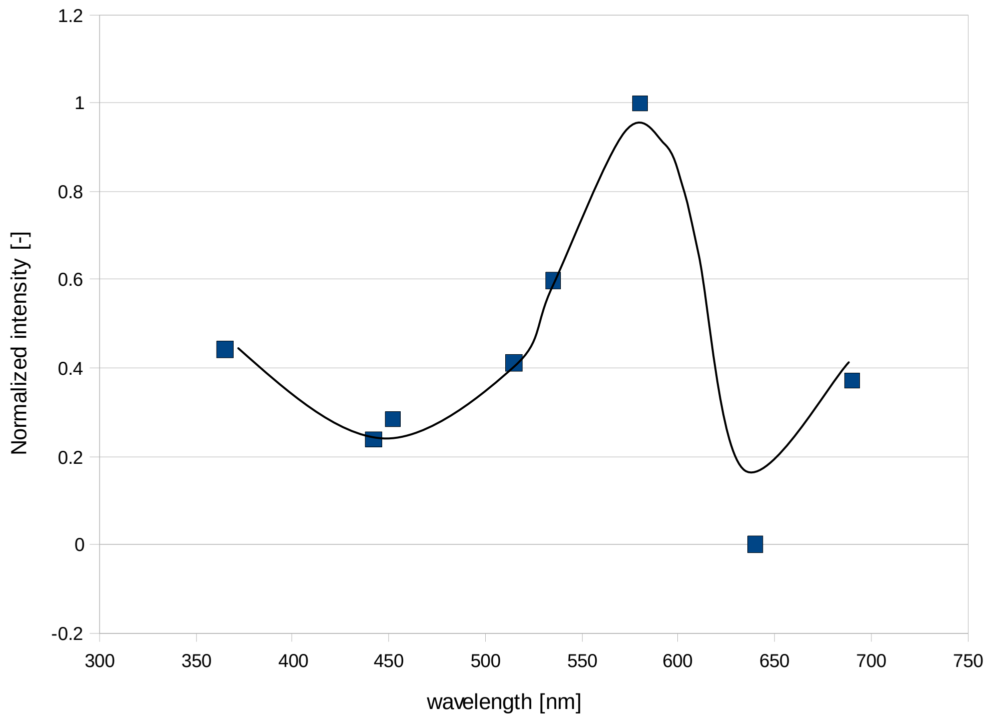

FIGURE 3. Spectrum of emission from solar cell surface

4. CONCLUSION

The radiation characteristics of light emitted from local regions of solar cell as a PN junction using the photomultiplier and optical filters has been measured. The computing algorithm was designed to measure in real time. This measurement is based on the determination of mathematical models of filters and their indices. It was found the significant maximum of emission for the wavelength of 580nm, which corresponds to the starting assumptions as the visible light emission can be observed. Furthermore, it was found that every local region with emission of visible light has the same characteristic

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