Optimizing of Fast Scanning Method

Kristýna Kubíčková
Doctoral Degree Programme (2), FEEC BUT
E-mail: xkubic15@stud.feec.vutbr.cz

Supervised by: Jiří Vaněk
E-mail: vanekji@feec.vutbr.cz

ABSTRACT

In this contribution we describe further improvement of novel diagnostic technique based on LBIC (Light Beam Induced Current) method for fast evaluation of solar cells quality. LBIC analysis is a widely used as universal method for detecting of local defects in the solar cell structure. Scanning of solar cell surface with single point light source (laser or LED focused beam) could take several hours of processing time depending on demanded picture resolution. An innovative method for fast scanning of solar cells based on the LBIC measurement was proposed and tested. Instead of laser beam a linear light source consistent of multiple SMD LED diodes is used. Scanning is performed in both X and Y axes. In principle one scan in each coordinate is sufficient.

The improvement of technique was done in the field of enhanced light stripe. There were tested several types of line light sources and their properties were compared. The width of line light beam is adapted to pinstripe by the help of cylindrical lens. High resolution of measurement is warranted by the exact and fast reading of measured data.

There was created new advanced design of sample movement below fixed stripe of light placed in the upper part of system. The contact field with the sample is placed in the holder movable in one axis only. The contact field must be turned about 90° for the scanning of solar cell in the second axis. The next sample holder motion is outwards. By this way the matrix of current responses is created. Data computation was made by MATLAB program. The resulting current response is influenced by all defects allocated in the actual position of the actuating light beam line. Evaluation software was created for mathematic processing of measured data. The final picture of current responses over the surface of evaluated solar cell is reconstructed from data matrix. Several mathematic methods for current map creation were tested and compared.

1. INTRODUCTION

For fast scanning there is possible to use the same workplace as for the LBIC method. In distinction to one point source of light in case of LBIC using fast scanning method there is a LED diodes light strip, which illumine exactly defined narrow section of the cell. The workplace (Fig. 1.) allows exact movement of light source in X direction. Light strip is about 110 mm long so the 100 x 100 mm^2 solar cell can be scanned completely in the whole width. To comply with the requirement of small proportions SMD – technology is used. Red LED diodes were selected, because of large depth of red light penetration into the silicon junction. The solar cell is scanned in X axis by the light source. In the following step the contact field rotates and the light comeback to the initial position.

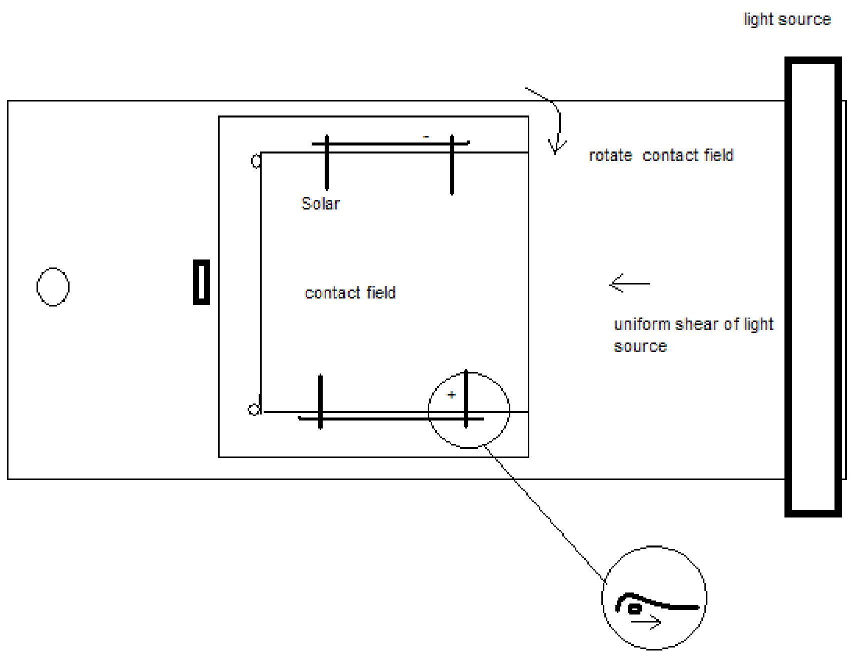

Fig. 1: Working place for Fast LBIC scanning.

Measuring procedure is controlled by personal computer, which governs the movement of the light strip over the solar cell surface and records the response signal value. From measured data a special file is created and transferred to the analysis program, which works in MATLAB environment. Analysis program implement reconstruction of acquired data values to the quadrate matrix, which indicates the positions of investigated solar cell faults. This matrix is displayed as a diagram, which allows visual check of defects positions. In the case that investigated solar cell has some defects the location of these defects can be thus determined very quickly.

Using this program it is possible to process the results of the solar cells scanning. Area with a defect can be zoomed in a given view and inspected in detail. Defects can be displayed in form of area or contour type. Both types are necessary for better orientation in results of measurement.

2. ANALYSIS OF FAST SCANNING MEHTOD

Experiments with Fast scanning method revealed the necessity of the method accuracy improving. Therefore, apart from a new workplace design also a MATLAB simulation program was created. Important function of this program is a backward reconstruction of scanned data. User can thus compare properties of particular methods and choose an optimal procedure. The best solution can be then implemented to practice. In this application it is also possible to add different scanning methods.

Because the MATLAB environment is not user friendly a graphic user interface was created which can be used for selection of scanning method, setting up of sensitivity and for definition of working files. Thanks to this application it is possible to collect considerable quantity of data. Data can be compared with old results and then the conclusions could be made up.

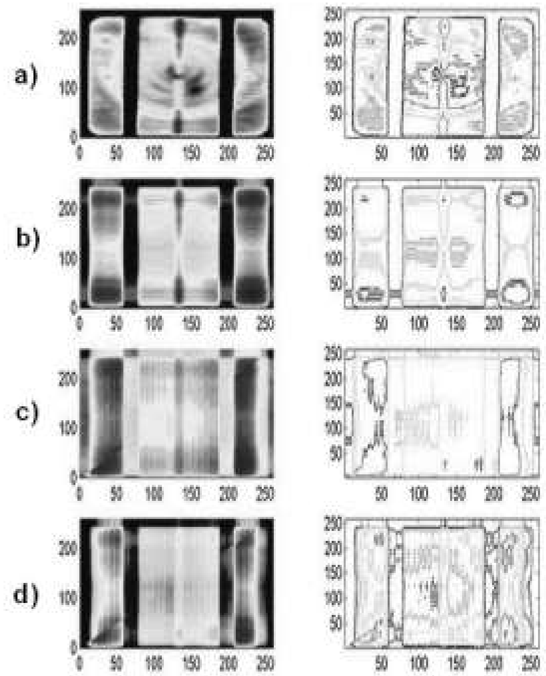

Fig. 2: Results of a simulation program.

Next Figure 2 shows the result of a simulation program. Defected pictures are displayed in colour scheme on the left side. Same pictures are displayed in contour graph on the right.

An image of solar cell with swirl defect is in part 2a. The input swirl defected file was transferred to a colour scheme by means of simulation program.

Scanning in the X and Y axis is displayed in part 2b. There is a long light strip in a workplace and then it is scanned over the full length of solar cell area. Problem of this method is so-called "reflection of defects". Axis point of intersection determines location of the defect. When there are several defects scanned, they are displayed in side axis point of intersection. During a reconstruction, localities (which display fake defects) come into being. This method is used for determination of location of defect. Advantage of used method is simplicity and rate of scanning.

Three scanning axis are located in part 2c and 2d, but with different sensitivity. Light strip scans over the solar cell in X, Y axis and also diagonal. Displacement of an image was caused by third axis, because of using rectangular matrix form. This method of scanning could be a solution of this problem of "reflection of defects". Disadvantage of this method is a long time scanning and a small specification compared to X, Y axis scanning method.

3. CONCLUSION

In photovoltaic industry, like in other industrial processes, there is necessary to check incoming materials and find a product faults. Integration of elementary control components and fast defection and localization of this faults is undoubtedly the way to higher yield and reliability of the solar cells. First experiments using the fast LBIC scanning method has shown that it is necessary to improve accuracy of this method. Therefore the simulation program was created and this way it is possible to make an assessment of real defects position and shape. Fast scanning method can be used in serial production for fast verification of solar cells. As compared to conventional LBIC proposed fast scanning method is not so accurate but for more accurate defect determination there is always a possibility of subsequent use of LBIC method, which already can be applied only by defective parts of investigated cells. Considerable reduction of time needed for verification of single cells is thus possible.

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