MEASURING OF MICROPLASMA NOISE AND NOISE CURRENT VS. REVERSE VOLTAGE DEPENDENCE

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ABSTRACT

The article describes an origin of a microplasma noise, its behaviour and one possibilitie of using. At first, it was necessary to find convenient solar cells. During the seeking of solar cells with a microplasma region, we tested approximately twenty pieces and only two of them were usable. We measured a dependence of current noise on a reverse voltage size, time behaviour of a microplasma noise and a VA characteristic of NT1 solar cell. Everything was compared with the data from solar cell K2.

1. INTRODUCTION

The formation of microplasma regions in PN junctions is attributed to crystal lattice imperfections. As a rule, these regions feature lower strong-field avalanche ionization breakdown voltages than other homogenous PN junction regions. The existence of such regions may lead to local avalanche breakdowns occurring in reverse-biased PN junctions at certain voltage. These local avalanche breakdowns may exhibit as a current impulse noise.

2. ANALYSIS

2.1. MICROPLASMA NOISE

Microplasma noise belongs to impulse noise and generates by local avalanche breakdown in crossing small areas. It appears when the reverse voltage is quite high, but it’s smaller than the avalanche breakdown voltage. The electric field intensity can decrease by the voltage variance influence in microplasma region under the minimum value, which is necessary to keep the discharging. Then the current steadies.

Noise appears in the form of two-level or multi-level rectangle current impulses. The multi-level current noise is caused by occurrence of microplasma in two or more areas in the same time. Constant amplitude, random occurrence time and random continuation time are characteristic for microplasma current noise impulses.

2.2. SOLAR CELLS UNDER INVESTIGATION

Each studied silicon solar cell has a PN junction. Top side of these cells is saturated by phosphorus so it makes *n*-type semiconductor. The silver grating is usually printed on underside and saturated by aluminium so it makes *p*-type semiconductor. PN junction creates by diffusion and n-type layer is much thinner than the p-type layer. The top side of cell is specially cauterized to decrease light reflectivity of surface and to get better absorption of illumination.

The analysis of microplasma noises determination its sources are very difficult because of large solar cell surface and uncountable number of local regions. Because of these reasons we measure not the whole solar cells but their separate fragments

2.3. MICROPLASMA NOISE MEASUREMENTS

Two levels microplasma noise can be usually observed in PN junctions of solar cells as it is shown in figure 1.

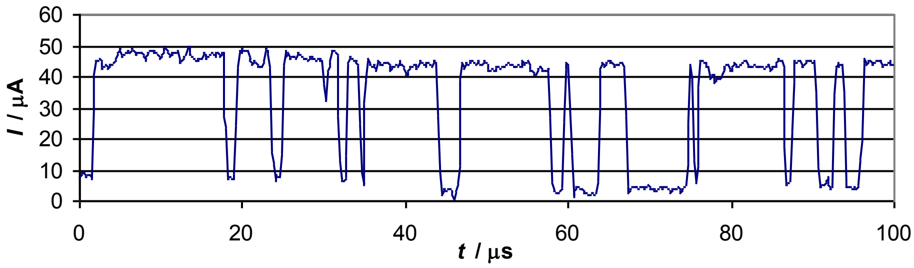

Figure 1: Two levels microplasma noise measurement. Voltage 9,75 V

The noise impulses are very short at the first time, but they become longer with increasing reverse voltage. This process leads to increasing of average current. After the reverse voltage exceeds some define value the current remains constant with increasing reverse voltage. This process can repeat with higher reverse voltage but for other microplasma.

The microplasma start-up voltages are sufficiently far from each other. Therefore areas between two close start-up voltages are not colliding. Voltage interval is voltage in bi-stable area of solar cell, when the microplasma noise appears.

Multi-level noise of sample NT1 was observed. This noise is located in two or more regions which are situated near close to each other and voltage intervals overlap. The example of multi-level noise is shown in figure 2.

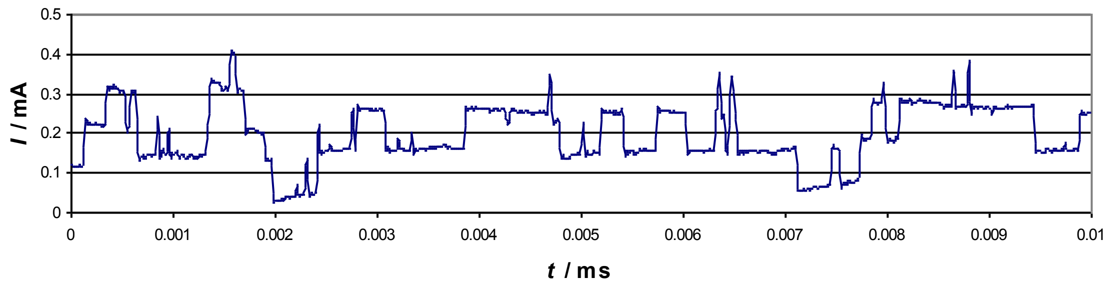

Figure 2: Multi-level microplasma noise measurement. Voltage 46,7 V

Technical literature shows that the single microplasmas of many level noises can influence each others. These problems will be studied in future research

2.4. NOISE CURRENT MEASURING OF SAMPLE NT1

The measuring workspace block schematic is shown in figure 3.

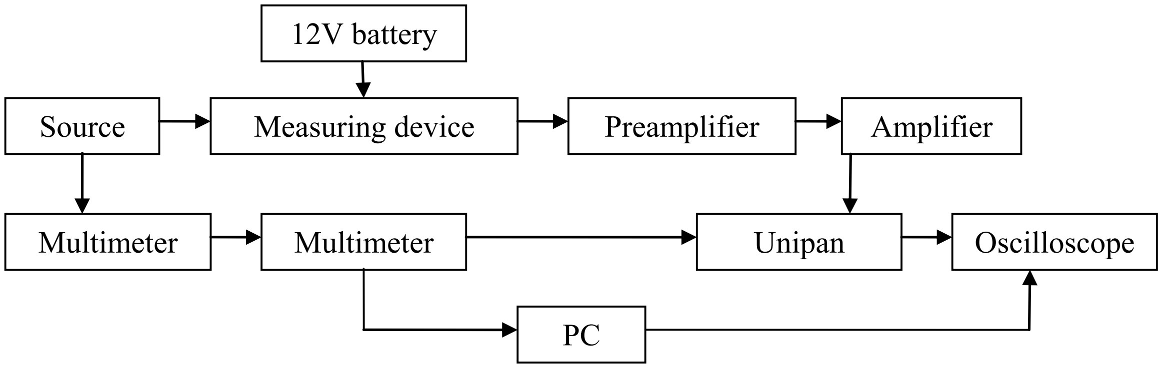

Figure 3: Workspace order

The supply voltage is regulated with power supply Agilent E3649A. The sample is placed between two electrodes of measuring device and one of the electrodes is connected to the resistor. The noise current is taken from this resistor. The current is amplified by the low noise preamplifier PA31 and low noise amplifier AM22. Analog device Unipan takes the output signal from amplifier AM22 and determines the effective value of narrow band noise. Unipan concludes the selective amplifier, which is tuned to variable frequency, in this case 420Hz. The oscilloscope can be used only for displaying of instantaneous value of measuring signal. Multimeters in figure 3 are used for the noise current measuring, solar cell reverse voltage and temperature measuring. The computer controls multimeters and power supply by the measuring program, which is shown in figure 4.

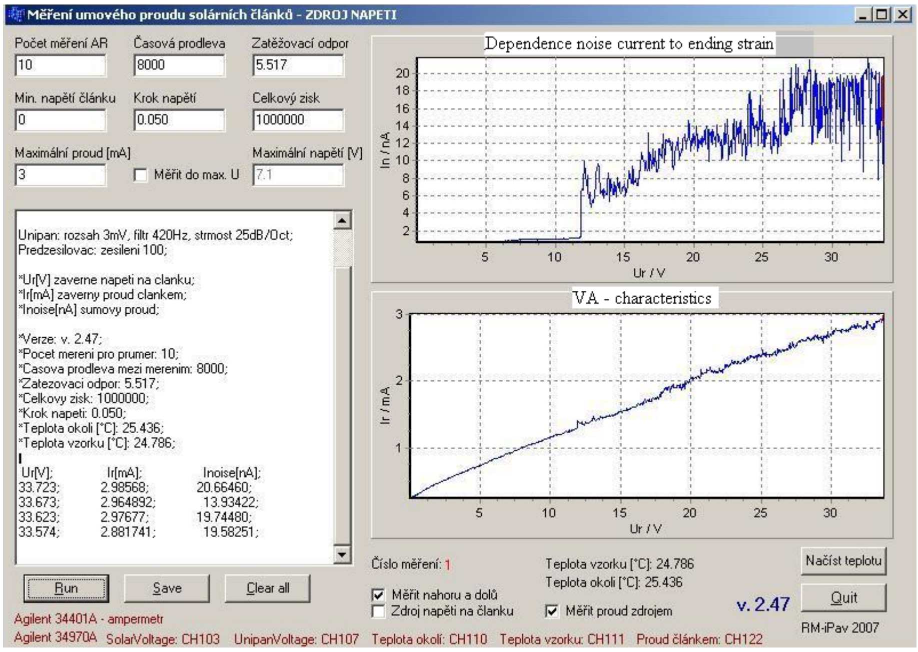

Figure 4: Control program for measurement noise current

Usual solar cell noise current process is shown in figure 5.

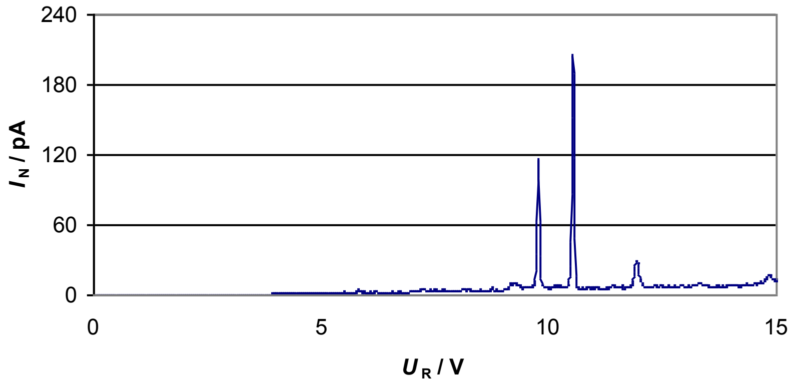

Figure 5: Noise current of solar cell K2

The single peaks reply for microplasma noise occurrence. Each microplasma noise occurrence depends on other reverse voltage. Three regions of microplasma noise occurrence has been turned up at sample K2, concretely for 9,75 V, 10,50 V and 11,88 V.

The noise current dependence on reverse voltage was measured for sample NT1. This dependence is in figure 6.

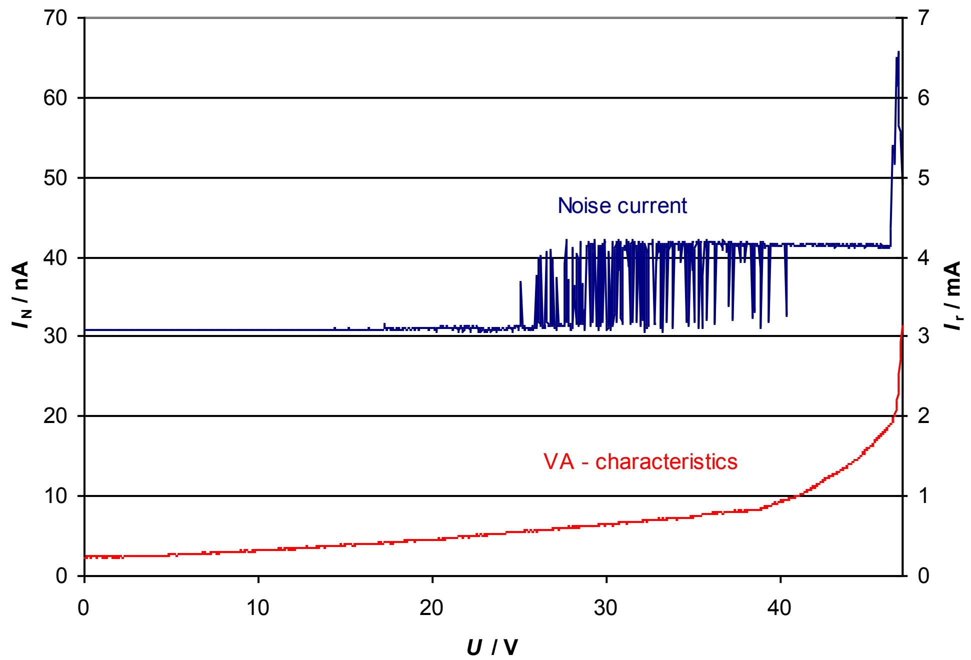

Figure 6: Noise current dependence on reverse voltage and VA – characteristics

The noise current appears when reverse voltage reaches 25 V. The fact, that the noise current balances during measuring is unusual, but its maximum value is stable. We have never observed this effect before. VA characteristic of cell have two turning points. The first turning point matches 39V, when the noise current is stabilized on constant value. The next turning point is at 46,4 V of reverse voltage. The two-level microplasma noise appears after this value of voltage and others microplasmas activate. The multi-level microplasma noise appears at 46,7V. The time behaviour at 46,7V of reverse voltage is in figure 2.

3. CONCLUSION

This article describes the microplasma noise, which can be used for nondestructive diagnostics of solar cells. We observed the multilevel microplasma noise in the solar cells for the first time. This noise located in two or more regions and the voltage intervals are overlapped in these regions. The first turning point on VA characteristic was found out at reverse voltage 39V, the noise current was steady at this time. During increasing of the reverse voltage, current increased very sharply. The microplasma noise appears at 46,4V (sample NT1), it causes additional current increasing.

The main aim for the next thesis is explaining variance of noise current between 24V and 40V, influence others microplasmas on active microplasma in case of multi-level noise and measure of the light emission from solar cell surface with photomultiplier. If the surface emits the light, the dependency between optical signal and electrical signal will be studied.

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